This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

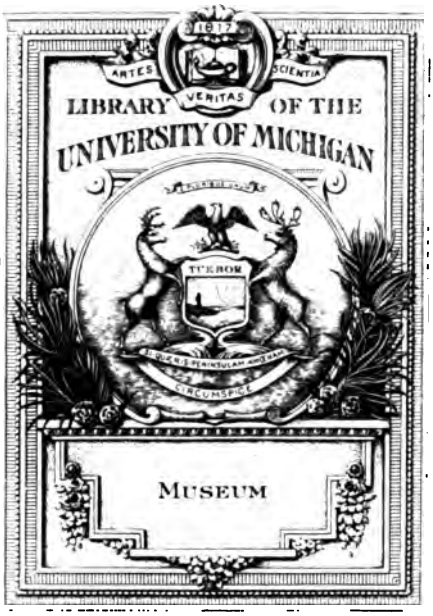
+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

B 1,280,805


ARTES
SCIENTIA
VERITAS
LIBRARY OF THE
UNIVERSITY OF MICHIGAN
TUEBOR
CIRCUMSPICE
MUSEUM

SH
25
.A3

SALE OF GOVERNMENT PUBLICATIONS.

The undermentioned firms have been appointed Sole Agents for the sale of Government Publications, including Parliamentary Reports and Papers, Acts of Parliament, Revised Office Publications, &c., &c., and all such works can be purchased from them either directly or through usual booksellers, who are entitled to a discount of 25 per cent. from the selling prices :—

IN ENGLAND :—

For all publications except Ordnance and Geological Maps, the Hydrographical Works of the Admiralty, and Patent Office Publications.—Messrs. Eyre and Spottiswoode, East Harding Street, E.C.

For Geological Maps.—Mr. E. Stanford, Cockspur Street, S.W.

For Hydrographical Works of the Admiralty.—Mr. J. D. Potter, 31 Poultry, E.C.

Patent Office Publications are sold at the Patent Office.

For all Publications except the Hydrographical Works of the Admiralty and Patent Office Publications :—

IN SCOTLAND.—Messrs. John Menzies & Co., 12 Hanover Street, Edinburgh, and 90 West Nile Street, Glasgow.

IN IRELAND.—Messrs. Hodges, Figgis, & Co., Limited, 104 Grafton Street, Dublin.

ORDNANCE SURVEY MAPS OF GREAT BRITAIN AND IRELAND.—There are Agents for the sale of these Maps in most of the chief towns. Copies can also be ordered of any Head Post Office, and through any Bookseller, or from the Director-General (Ordnance Survey, Southampton); or in the case of Ireland, from the Officer in Charge Ordnance Survey, Dublin.

The following is a list of some of the more important Parliamentary and Official Publications recently issued :—

Parliamentary :

Statutes :—

Public General Statutes 1899. With Index, Tables, &c. (Cloth). Price 9*s.*

Second Revised Edition. 5 & 6 Will. IV. to 5 & 6 Vict. 1835–1842. XV. Vols. Price 7*s.* 6*d.* each.

Second Edition. Tables showing subsequent Repeals, effected by Acts of Session 52 & 53 Vict. 1889. Price 6*d.*

Statutes in Force. Index to. 15th Edition. To end of 59 & 60 Vict. 2 Vols. Price 10*s.* 6*d.*

The Statutory Rules and Orders revised. Statutory Rules and Orders, other than those of a Local, Personal, or Temporary Character, issued prior to 1890, and now in force. Vols. I. to VIII. Price 10*s.* each.

Statutory Rules and Orders, other than those of a Local, Personal, or Temporary Character. With a List of the more important Statutory Orders of a Local Character arranged in classes; and an Index to the Titles. Issued in the years 1891, 1892, 1893, 1894, 1895, 1896, 1897, 1898, and 1899. Price 10*s.* each.

Statutory Rules and Orders in force on 31st December 1899. Index to. Price 1*s.*

Statutory Rules and Orders, 1900. Prepared under the Rules Publication Act, 1893. In course of issue.

Acts of Parliament, Public and Local and Private. Session 1900. In course of issue.

[3 C. No. 9] [1899.] Life Assurance Companies. Statement of Accounts, 1899. Price 2*d.*

[3 C. No. 134] [1901.] Corn. Tables showing Declarations, &c., 1892 to 1899. Price 3*d.*

[Cd. 46.] Anniversaries, Returns. Great Britain. 1899. Price 1*d.* 4*d.*

[Cd. 67.] Army Deferred Pay. Report of Departmental Committee on the Financial Aspects of Proposals; with Appendices. Price 1*s.* 3*d.*

[Cd. 187.] Mines and Quarries. General Report and Statistics, 1899. Part I. Coal, shale, fireclay, ironstone, &c. Price 8*d.*

[Cd. 189.] Railway Accidents Returns and Reports, 1898 1899. Price 3*s.* 5*d.*

[Cd. 191.] Universal Classification of the Universe Synopsis. Library Departmental Directory. Price 7½*d.*

[Cd. 284, 330 to end.]

[Cd. 289.] Education. Directory with Regulations for establishing and conducting Science and Art Schools and Classes. 1900-1901. Price 6*d.*

[C. 1 109.] War Rebate Prize Committee. Report and Treasury Minute. Price 2*d.*

Mines. Reports of His Majesty's Inspectors for 1899, with Summaries of the Statistical portion under the provisions of the Coal Mines Regulation Act, 1887; Metalliferous Mines Regulation Act, 1872; Mine Mines (Qualifying) Act, 1852; Districts Nos. 1 to 23. Complete. Price 7*s.* 6*d.*

Wages in the United Kingdom with the Law of Wages Act, 1896. Price 2*d.*

Statistics 1900. Price 2*d.*

Mines Inspectors. List of the Inspectors appointed to 31st December 1899. Price 1*d.*

EIGHTEENTH

ANNUAL REPORT

OF THE

FISHERY BOARD FOR SCOTLAND,

Being for the Year 1899.

IN THREE PARTS.

PART I.—GENERAL REPORT.
PART II.—REPORT ON SALMON FISHERIES.
PART III.—SCIENTIFIC INVESTIGATIONS.

PART III.—SCIENTIFIC INVESTIGATIONS.

Presented to Parliament by Command of Her Majesty.

GLASGOW:
PRINTED FOR HER MAJESTY'S STATIONERY OFFICE
BY JAMES HEDDERWICK & SONS,
AT "THE CITIZEN" PRESS, ST. VINCENT PLACE.

And to be purchased, either directly or through any Bookseller, from
JOHN MENZIES & CO., 12 HANOVER STREET, EDINBURGH, and
90 WEST NILE STREET, GLASGOW; or
EYRE & SPOTTISWOODE, EAST HARDING STREET, FLEET STREET, E.C., and
32 ABINGDON STREET, WESTMINSTER, S.W.; or
HODGES, FIGGIS, & CO., LIMITED, 104 GRAFTON STREET, DUBLIN.

1900.

[Cd. 211.] *Price* 3*s*. 9*d*.

CONTENTS.

PAGE.

GENERAL STATEMENT 7
The Influence of Trawling 8
The Hatching and Rearing of Food Fishes 12
The Life-History of the Edible Crab 13
The Parasites of Fishes 14
Seine-Net Fishing for Herrings 15
The Mackerel of the East and West Coasts of Scotland . . 16
The Fishes of the Firth of Clyde 17
The Surface Currents of the North Sea 17
The Natural History of the Plaice 17
The Classification of the Flat Fishes 18
The Invertebrate Fauna 18

APPENDICES.

SCIENTIFIC REPORTS.

I. Report on the Trawling Experiments of the "Garland," and on the Fishery Statistics relating thereto . . . 19
Introductory 19
The Firth of Clyde 20
The Moray Firth 22
Table A.—Showing Summary of Fish taken by the "Garland" in Trawling Operations in 1899 28
Table B.—Analysis of the "Garland's" Statistics relating to the relative Abundance of Fish 32
Table C.—Record of Observations made on Board the "Garland" during 1899 33
A. Fish caught 33
B. Physical Observations 59
Table D.—Showing the Quantities of Fish caught by Line within the Moray Firth (inside a Line between Duncansby Head and Rattray Point), and the Number of Shots of the Boats by which the Fish were caught 69
Table E.—Total Quantities of Fish caught by Line within the Moray Firth (inside a Line between Duncansby Head and Rattray Point), and the Number of Shots of the Boats by which the Fish were caught . . 76
II. Contributions to the Life-History of the Edible Crab (*Cancer pagurus*, Linn.). By H. Chas. Williamson, M.A., B.Sc. (Plates I.-IV.)
Introduction 77

PAGE.

Size of Crab at Maturity :—
The Mature Female Crab 79
Fertilisation 82
Annual Spawning 85
Times of Spawning and Hatching . . . 88
Number of Eggs of Berried Crab . . . 89
The Mature Male Crab 97
External Sexual Characters 98
Proportional Numbers of the Sexes 99
Exuviation, Casting 104
The Occurrence of Soft Crabs 105
Frequency of Casting 109
Regeneration of Lost Limbs : the Repair of Injuries . . 111
Rate of Growth and Distribution 113
The Migrations of Crabs 119
The Regulation of the Crab Fishery 134
Description of the Plates 143

III. Notes on some Crustacean Parasites of Fishes. By Thomas Scott, F.L.S., Mem. Zool. Soc. de. France. (Plates V.-VIII.)
Introductory Note 144
Copepod-Parasites of Fishes 145
" " " —Ergasilidæ . . . 146
" " " —Caligidæ 147
" " " —Dichelestidæ . . . 159
" " " —Lernæidæ . . . 160
" " " —Chondracanthidæ . . 163
" " " —Lernæopodidæ . . . 169
Branchiura 179
Isopoda parasita 180
Amphipoda parasita 180
List of Fishes on which Copepod-Parasites have been found . 181
Concluding Remarks 182
Description of the Plates 183

IV. Contributions towards the Natural History of the Plaice (*P. platessa*, L.). By H. M. Kyle, M.A., B.Sc., Exhibition Science Scholar, St. Andrews. (Plates IX.-X.)
Introduction 189
Average-Size at First Maturity 190
Variability and the Method of Treating Variations . . 201
The Various Forms of Variability 207
I. Sex-Variability 207
II. Growth-Variability 212
III. Race-Variability 220
Conclusion 237

V. Report of an Enquiry on the Action of the Herring Seine-Net. By T. Wemyss Fulton, M.D., F.R.S.E., Scientific Superintendent 242

VI. The Fishes of the Firth of Clyde. By Thomas Scott, F.L.S., Member Soc. Zool. de France 272

VII. On the Mackerel of the East and West Coasts of Scotland. By H. Chas. Williamson, M.A., B.Sc. 294

PAGE

VIII. Report on the Operations at Dunbar Marine Hatchery during the Spring Season 1899. By Harold C. Dannevig . 330

IX. The Classification of the Flat Fishes (*Heterosomata*). By H. M. Kyle, M.A., B.Sc., Exhibition Science Scholar, St. Andrews. (Plates XI.-XII.) . . .

Introduction 335
Description of Characters 335
Characters of most importance for classification . . 348
Classification 351
Geographical Distribution 362
Description of the Plates 368

X. Additional Note on the Surface-Currents of the North Sea. By T. Wemyss Fulton, M.D., F.R.S.E. . . 370

XI. Notes on Some Gatherings of Crustacea collected for the most part on Board the Fishery Steamer "Garland" and examined during the past year (1899). By Thomas Scott, F.L.S., Member Zool. Soc. de France. (Plates XIII.-XIV.) 382

EIGHTEENTH ANNUAL REPORT.

TO THE RIGHT HONOURABLE

LORD BALFOUR OF BURLEIGH.

Her Majesty's Secretary for Scotland.

OFFICE OF THE FISHERY BOARD
FOR SCOTLAND,
EDINBURGH, 1*st May* 1900.

MY LORD,

In continuation of our Eighteenth Annual Report, we have the honour to submit—

PART III.—SCIENTIFIC INVESTIGATIONS.

GENERAL STATEMENT.

In this part of the Eighteenth Annual Report an account is given of the results of the principal scientific investigations conducted by the Board during the year 1899 in connection with the sea fisheries. Besides the researches related to the life-history and habits of the food fishes and on the invertebrate fauna described in the following pages, a number of other inquiries have been in progress but are not yet completed, among which may be mentioned the rate of growth and migration of fishes, the distribution of spawning fishes and of immature fishes, and on the fauna of the Moray Firth. An investigation was also made in the spring on the condition of the clam-bait bed in the Firth of Forth.

The scientific researches are being conducted at the Board's Marine Laboratory at the Bay of Nigg, Aberdeen, where it is hoped the tanks and apparatus which are necessary for such investigations may be provided in the course of the present year. A considerable part of the work has also been carried on by the small steamer the *Garland*, but, as has been fully explained in preceding Reports, this vessel is not well adapted for the purpose, owing to her small size and considerable age. In consequence of these disabilities, the observations are frequently interrupted by stormy weather and the necessity of repairs, so that they cannot be carried out with regularity. This has prejudicially affected, and continues to affect, the trawling experiments, and it has prevented any systematic investigation of the spawning grounds off the coast, as

well as others of importance. The inefficiency of the *Garland* in this department may be understood from the fact that it is not possible with it to follow up the life-history and movements of the principal food fishes from the inshore to the offshore waters, or *vice versa*, or to make observations on the great fishing grounds where fishermen mostly pursue their industry, and where the greater part of the fish supply is obtained.

The Influence of Trawling.

The results of the trawling operations carried on in the course of the year, together with the various Tables embodying the observations in detail, are given in a separate report (p. 19). During the year the investigations were conducted in the Firth of Clyde, where the stations were examined in January, May, June, July, September, October, November, and December. The work was considerably interrupted by stormy weather and the necessity of taking the vessel into harbour for repairs. The number of fishes captured with the ordinary trawl at the Clyde stations was close upon 20,000, of which the majority were flat-fishes. A feature of contrast with the condition on the East Coast is the scarcity of plaice, the most abundant flat-fishes being witches and long rough dabs, which formed over 80 per cent. of all the flat-fishes caught. The statistics for the various kinds of fish caught at the twelve stations show that the average for the year for all kinds together was 176·9 per haul; the average for flat-fishes was 103·7; and that for round-fishes (cod, haddock, whiting, and gurnard), 34·7. Among flat-fishes the average for plaice was only 1·5; that for lemon soles was 7·2; while witches had the high average of 41·7. The dabs had also high averages—for the common dab, 14·9, and for the long rough dab, 36·5. Other species of flat-fishes were taken in small numbers, including, for all the hauls, a total of 60 black or common soles. Among round-fishes, gurnards headed the list with an average of 22·3; the average for cod was only 1; for whitings, 9·4; and for haddocks, 2.

Comparison of the results obtained in the years in which the investigations have been made in the Clyde show that the general average has increased over the period. In 1888 it was 109·7 per haul; in 1890, 99·5; in 1895, 113·4; in 1896, 120·7; in 1897, 112·5; in 1898, 189·3; and last year, 176·9. The statistics for flat-fishes and round-fishes indicate a fairly steady rise in the former and considerable fluctuation in the latter. The figures are as follows:—

	1888.	1890.	1895.	1896.	1897.	1898.	1899.
Flat-Fishes .	61·2	61·1	64·7	75·5	84·8	94·7	103·7
Round-Fishes .	44·7	35·1	43·6	35·1	27·8	49·9	34·7

When the statistics relating to the various species are considered, it is found that the increase among the flat-fishes has been principally in witches and long rough dabs, as shown by the following averages:—

	1888.	1890.	1895.	1896.	1897.	1898.	1899.
Plaice . .	5·3	3·4	2·3	2·1	2·5	3·0	1·5
Lemon Soles .	7·4	5·6	2·8	7·2	5·3	4·1	7·2
Witches . .	12·7	19·7	25·7	35·9	47·1	36·5	41·7
Common Dabs .	23·8	13·8	14·0	15·7	12·7	13·6	14·9
Long Rough Dabs	5·3	17·7	20·0	15·1	16·8	37·3	36·5

The same general result is shown when the averages for the comparable months are considered, with the exception of December 1898, witches and long rough dabs exhibiting a substantial increase, and plaice a diminution.

The trawling investigations begun in Loch Fyne in 1896 show that, within the period, witches and long rough dabs have also given an increased average, while plaice do not indicate the same diminution as at the outer stations. Inasmuch as the observations hitherto made in the Clyde comprise a comparatively small number of hauls, especially in the earlier years, inferences as to changes in the abundance of the fishes in the closed area must be provisional.

The special statistics which have been collected for the past six years, showing the quantities of fish caught in the closed waters of the Moray Firth by line-fishermen, are appended to the Report. The following figures indicate the quantities landed in each district in each of the years, as well as the average weight taken per "shot" of the line:—

District.	1894.		1895.		1896.		1897.		1898.		1899.	
	Cwts.	Average.	Cwts.	Average.	Cwts.	Average.	Cwts.	Average.	Cwts.	Average.	Cwts.	Average.
Wick . .	19,008	2·47	23,000	4·03	31,556	5·40	44,258	6·16	31,383	6·49	26,116	5·106
Lybster .	4,408	4·91	3,977	3·77	4,241	2·87	7,118	4·22	4,438	3·26	4,309	1·398
Helmsdale .	15,826	3·52	16,669	4·15	18,360	4·71	17,148	4·93	13,143	3·84	12,752	3·85
Cromarty .	21.346	3·07	19,193	2·93	15,317	2·51	14,736	2·48	12,428	2·065	11,183	1·815
Findhorn .	60,074	4·04	68,761	4·86	63,521	4·46	46,694	2·66	30,770	2·088	31,825	1·957
Buckie .	48,540	4·21	50,489	4·66	57,450	5·05	50,067	4·77	41,102	4·24	34,915	3·357
Banff . .	49,292	2·94	76,491	4·77	66,471	3·82	61,329	3·70	36,057	2·13	26,675	2·406
	218,494	3·06	258,589	4·43	256,916	4·26	241,350	3·83	169,321	3·244	147,775	2,666

When these quantities are compared with those given in the Tables in Part I. of the Board's Report, showing the gross quantities landed, irrespective of the place of captnre, it will be found that by far the greater part of the line-caught fish in each district is taken from the Moray Firth. Last year 147,775 cwts. out of a gross quantity of 180,649 cwts. were so derived. In all the districts, indeed, except Wick, all the fish caught by line are returned as derived from the closed waters. In previous years this was the case with only a few of the districts, and the circumstance seems to point to a greater restriction of line fishing in this area.

The gross quantity taken from the Moray Firth by line-fishermen in 1899 was less than in any preceding year. As compared with the previous year, the decrease amounted to 21,546 cwts.; as compared with 1895 the decrease was 110,814 cwts., and each year since that named has exhibited a progressive decline. The average catch per "shot" of the line has also decreased during the same period. In 1895 it was 4·43 cwts.; in 1898, 3·24 cwts.; and last year only 3·66 cwts. The diminution was not, however, confined to the Moray Firth. The general statistics for the rest of the East Coast and for the whole of the coasts of Scotland show a corresponding change, and in the same kinds of fishes.

With respect to the various kinds of fishes caught by line in the closed waters, the following Table shows the quantities and the average weight per "shot" for each of the six years:—

FISH.	1894.		1895.		1896.		1897.		1898.		1899.	
	Cwts.	Average.	Cwts.	Average.	Cwts.	Average.	Cwts.	Average.	Cwts.	Average.	Cwts.	Average.
Cod - -	32,571	0·52	47,646	0·81	64,663	1·07	79,731	1·26	56,208	1·07	52,753	0·95
Ling - -	2,169	0·035	2,037	0·005	3,868	0·062	3,544	0·056	2,567	0·049	2,883	0·052
Torsk - -	25	0·002	24	—	94	—	25	—	43	—	82	—
Saithe - -	6,120	0·09	5,083	0·087	10,636	0·17	11,761	0·18	14,881	0·28	9,375	0·169
Haddock -	153,529	2·47	178,370	3·056	156,703	2·6	126,031	2·004	81,098	1·554	68,075	1·229
Whiting -	5,845	0·094	5,114	0·087	4,836	0·08	3,319	0·052	1,535	0·029	1,323	0·023
Turbot - -	5	—	—	—	15	—	16	—	13	—	60	—
Halibut -	254	0·004	403	0·007	691	0·011	707	0·011	730	0·013	702	0·013
Lemon Sole -	—	—	—	—	19	—	14	—	1	—	6	—
"Flounder, Plaice, and Brill" - -	5,477	0·088	5,765	0·09	3,402	0·056	3,978	0·063	3,425	0·065	5,005	0·09
Conger - -	1,244	0·02	777	0·013	823	0·013	1,533	0·024	826	0·015	741	0·013
Skate - -	3,281	0·053	3,014	0·051	3,683	0·061	3,999	0·063	3,273	0·062	3,584	0·064
Other kinds of White Fish -	7,976	0·128	9,456	0·16	7,483	0·12	6,663	0·105	4,574	0·087	3,116	0·056

The most important of the fishes are cod and haddocks, and both show a decrease from the previous year. That in cod was comparatively slight, amounting for the year to 3405 cwts., the average per "shot" also falling from 1.07 to 0·95 cwts. The total and the average were, however, both lower in the years 1894 and 1895; since 1897 the gross quantity and the average have diminished.

The decrease in the quantity of haddocks caught by line in the Moray Firth is more noteworthy. In 1898 the amount landed was 81,098 cwts., while last year it was 68,075 cwts., or nearly 14,000 cwts. less. The average catch per "shot" also declined from 1·554 to 1·229 cwts., the lowest since the statistics began to be collected. Since 1895 both the gross quantity landed and the average weight taken per "shot" of the line have fallen in each successive year. In 1895 the total was 178,370 cwts., and the average per "shot" 3·06 cwts.

There was also a decrease last year in the quantity and average catch of saithe or coal-fish landed. Unlike the cod or haddock, the saithe had been gradually increasing from 1895. Throughout the whole period of six years whitings have shown a gradual and continuous decline. In 1894 the quantity amounted to 5,845 cwts., and the average per "shot" was 0·09; last year the quantity was 1323 cwts., and the average 0·02. Conger also slightly diminished, while skate slightly increased, the average per "shot" remaining the same.

Among flat-fishes, on the other hand, an increase occurred as compared with the previous year; but the quantity caught by lines in the Moray Firth is not very large. The total weight landed in 1898 was 4169 cwts., while 5833 cwts. were landed in 1899. The quantities landed in each of the years, and the percentage of the total catch are as follows:—

	1894	1895	1896	1897	1898	1899
Cwts.	5,736	6,170	4,127	4,715	4,169	5,833
Percentage of Total Catch	2·6	2·3	1·6	1·9	2·5	3·9

Very few lemon soles were taken by lines, only six cwts. during the year; turbot increased from 13 cwts. in 1898 to 60 cwts. last year, and halibut from 730 to 762 cwts. The increase in the group comprised under the heading "flounder, plaice, and brill" was more considerable, namely, from 3425 cwts. in 1898 to 5005 cwts. in 1899, the respective averages being 0·06 and 0·09, and the increase took place almost entirely in the three districts of Helmsdale, Cromarty, and Findhorn.

The statistics dealing with the number of "shots" of the line-fishing boats, or the number of visits made to the fishing grounds, show that an increase occurred last year as compared with 1898. The figures for the whole of the Moray Firth in each of the years are as follows:—

	1894	1895	1896	1897	1898	1899
Large Boats .	7,082	7,710	11,915	14,039	10,330	12,665
Small Boats .	54,866	50,643	48,3 6	48,836	41,853	42,808
	61,948	58,353	60,261	62,875	52,183	55,473

It will be observed that while the number of "shots" of the small-line boats has declined over the period, the number of "shots" of the great-line boats has increased. On the whole, however, line-fishing in the Moray Firth has declined during the last two years.

As has been said, the fluctuations in the abundance of the fish caught by line in the closed waters in the various years, have been part of a general change along the coast, and cannot therefore be ascribed to a special cause. At the same time it is evident that the operations of the foreign trawlers, which have frequented the Firth in considerable numbers during the past few years cannot be without influence; and their presence must materially interfere with the results of the trawling investigations which were initiated after the Firth was closed.

The Hatching and Rearing of Food Fishes.

As explained in last year's Report, it was found necessary to continue the hatching operations at Dunbar during the season of last year, since the construction of the large tank at the new site at the Bay of Nigg had been suspended in the preceding September. The work consisted, as in preceding years, in the hatching of the eggs of the plaice, and the same methods were adopted. Adult plaice to serve as spawners for the supply of fertilised eggs were procured from trawlers in February and March, a little over 400 males and females being thus obtained. As in preceding years a considerable number of the fishes subsequently died owing to injuries received while being captured, and others remained in an egg-bound condition.

The collection of the fertilised eggs from the spawning-pond commenced early in March, and continued until the end of April, the total number procured being 18,700,000, from which 16,470,000 fry were obtained. These were transferred in batches to the upper waters of Loch Fyne, off Inveraray, at various dates in April and May, and there liberated.

The numbers of fry of the various species of marine food fishes, whose eggs have been hatched at Dunbar since the work was commenced, are as follows:—

	Plaice.	Cod.	Lemon Soles.	Turbot.	Others.	Total.
1894	26,060,000	500,000	...	...	...	26,560,000
1895	38,615,000	2,760,000	4,145,000	3,800,000	1,050,000	50,370,000
1896	11,350,000	750,000	1,580,000	1,360,000	950,000	15,990,000
1897	24,370,000	...	...	...	...	24,370,000
1898	19,200,000	...	...	...	...	19,200,000
1899	16,470,000	..	...	...	...	16,470,000
	136,065,000	4,010,000	5,725,000	5,160,000	2,000,000	152,960,000

At the close of the season's work the hatchery was dismantled and transferred, with the apparatus, pumps, and plant, to the new site at the Bay of Nigg, Aberdeen, and re-erected there. The large concrete tank, referred to in the preceding Report, was completed towards the close of the year. It was found to work satisfactorily, and as it has a capacity of about 160,000 gallons, and is so sunk in the ground as to admit the sea, through a twelve-inch pipe, at half-tide, it ought to be able to contain a large number of spawners, and will form a valuable adjunct to the establishment. The collection of adult plaice for the ensuing hatching season was begun in December. An additional concrete tank to contain about 60,000 gallons of water was built on an elevated part of the site, to act as a reservoir to supply the hatching apparatus in the night during the hatching season, and the tanks in connection with the laboratory at other times of the year.

The Life History of the Edible Crab.

In the present Report will be found a paper by Mr. H. C. Williamson, describing the results of an investigation into the life-history of the edible crab, which he has conducted during the past two years. The edible crab is one of the shell-fish which have formed the subject of legislation, the Fisheries (Oyster, Crab, and Lobster) Act of 1877 having prohibited the sale or possession of any crab of less than 4¼ inches across the back, of any soft crab, or of any crab with the spawn attached; and since then the District Fisheries Committees in England have made many bye-laws still further regulating the fishery in that country. At the same time it has been felt that much fuller information than existed concerning the life-history and habits of the crab is required in order to follow the operations of these regulations; and it was principally with this object in view that the research was begun.

The result of this research is to throw a considerable amount of light upon such important problems as the size at maturity, the seasonal migrations, distribution, and the season of casting. It was found that a female crab may be potentially mature when it measures about 4⅛ inches across the broadest part of the back; many between this size and 5⅜ inches, probably about a half, are

functionally immature; all those above 5⅜ inches were found to be mature and fertilised. The male crab becomes ripe at a smaller size, and all those above 4¼ inches are probably mature. The males and females are in almost equal abundance, the examination of several thousands of specimens showing that 98 males exist to every 100 females.

The crab spawns its eggs, which may number several millions, from November to January, in deep water, and they are hatched inshore in July and August, the period of incubation being seven or eight months, batches of eggs, as a rule, being carried in two successive years, at least, before the crab casts its shell. With regard to casting—an important subject from the point of view of close-times which have been proposed—it was found that while it may occur during a large part of the year—namely, from May to November inclusive—it takes place principally in July, August, and September. The largest numbers of soft crabs are obtained from August to November inclusive, and principally in September. Experiments showed that the time taken for a soft crab to harden, and therefore to become legally marketable, varied considerably. The great majority take from three and a half to four months, and large numbers remain "soft" in the legal sense from 90 to 100 days after casting. When the crab is approaching the mature size casting probably occurs once a year, but mature crabs above 4¼ inches do not cast every year, and the female not oftener than once in two years. With regard to distribution, it appears that the post-larval and earliest young stages, up to ⅛ of an inch in breadth, are probably restricted to the shallow shore waters; those from this size up to 2¼ inches are to be found between tide-marks; a little larger (up to 4 inches) they are littoral, outside low-water mark; and those of 4 inches and upwards, or the mature group, are found in winter offshore, beyond the twenty-fathom line at Dunbar, and in the spring and summer in the inshore waters.

Numerous experiments were made, with interesting results, regarding the seasonal migrations, and the movement of those which were marked and recovered are indicated on a chart accompanying the paper. The migration seawards appears to occur during August and September, and the inshore migration begins usually in February. The statistics of the crab fishery and its regulation are also considered. In connection with this investigation it was discovered that the Board had not the power, which is possessed by the District Fishery Committees in England, to permit the possession of berried crabs for scientific research, or for any purpose except for use as bait, in terms of the Act of 1877. A number of berried crabs had been obtained in ignorance of this difficulty, but the provision referred to greatly restricted the investigation, and it would be advantageous if the Board obtained the same powers as the English Committees have to allow the use of such crabs for scientific investigations.

The Parasites of Fishes.

In a paper by Mr. Thomas Scott the results of his investigation

on the crustacean parasites of fishes are described. Scarcely any part of a fish is free from such parasites; they are found running over the skin, they adhere to the fins, the gills, and gill-covers, they are found on the lips, the tongue, and the roof and sides of the throat, in the nasal fossæ, and even attached to the eye. For this research a very large number of fishes were examined, belonging to forty-seven species, and obtained for the most part by the *Garland* at various parts of the coast or at the Fish Market, Aberdeen. The majority yielded one or two kinds of parasites only, while on a few as many as four or five different species were obtained. The grey skate furnished the largest number, six different kinds having been found on specimens of this species. The saithe and torsk came next with five species each; the hake and toper yielded four, while three each were obtained on the common gurnard, the halibut, the turbot, the plaice, the conger, and the sun-fish. Eleven fishes yielded two, and twenty-six only one species of parasite each.

The number of species of parasites which are described in the paper is 66, of which 59 belong to the Copepoda, 5 to the Isopoda, and 2 to the Amphipoda. Of the Copepod species, a group in which Mr. Scott is one of the leading authorities, six of the species described are new to science. Some of these parasitic crustaceans are so strangely abnormal and grotesque in form that the most experienced naturalists have failed to recognise their relationship to the Crustacea until the study of their development and life-history revealed their true affinity. The paper is illustrated by numerous figures.

Seine-Net Fishing for Herrings.

The alleged injurious action of the seine-net in the herring fishery has been for some time under investigation with the view of ascertaining whether the two principal objections which have been urged against this mode of fishing—namely, the wasteful destruction of the herring-spawn deposited on the bottom, and of immature herrings—are well founded. For several years, as stated in previous Reports, arrangements were made to conduct investigations at the well-known spawning ground, Ballantrae Bank, off the Ayrshire coast, but owing to the failure of the fishing in successive seasons seine-net boats scarcely took part in it, and the observations could not be made. Last year, however, and still more markedly in the present season, the herrings reappeared on the bank in considerable numbers, and an investigation was made by the assistance of the *Garland*. The results of this enquiry and of the corresponding enquiry made in Loch Fyne are given in a paper in the present Report by Dr. T. Wemyss Fulton, the Scientific Superintendent.

It was found that while the seine-net may capture considerable quantities of small herrings which would escape capture by the drift-net or the trammel-net, and may be the means of occasionally destroying quite immature herrings, the evidence shows that the action of the seine-net in Loch Fyne has not been unnecessarily wasteful, or injurious to the permanence of the supply of herrings from the loch. Statistics prove that while the number of seine-net

boats in relation to the number of drift-net boats has increased, the quantity of herrings captured has not only not diminished, but has been steadily augmented over a period. During the five years 1889 to 1893 the gross quantity of herrings taken from Loch Fyne was 213,068 cwts., or an annual average of 42,613 cwts., while during the five years 1894 to 1898 the gross quantity was 573,415 cwts., and the annual average 114,683 cwts.

At Ballantrae Bank the investigation showed that the seine-net, which drags upon the bottom in the comparatively shallow water there, occasionally brings up deposited herring-spawn attached to the fronds of seaweeds, or coating the stones and gravel. Of 79 nets examined immediately after they were hauled, 63 showed no trace of deposited spawn, while in 16 cases spawn was found. The quantity, however, was small, and the amount of injury caused in this way by the seine-net is probably inconsiderable. At the same time, the conditions of the fishery at Ballantrae Bank are very different from what they are in Loch Fyne, where the water is very deep, and fishing operations are confined to the surface stratum. At the former place the water is only from seven to twelve fathoms in depth, and the seine-net extends quite from the surface to the bottom, taking everything within its reach. The herrings caught are spawning fish from which the eggs are running, the area of the bank is limited, and it is admitted that by an excessive use of the seine-net the herrings could be practically cleared from it in a short time. The statistics show a great decline in the fishery following the years of abundance, when hundreds of seine-boats frequented the ground; and while this may be due merely to natural fluctuation, the view that it may have been caused by excessive use of the seine is not inconsistent with the evidence. It is considered desirable, however, to continue the investigations for another year or two.

In the Clyde generally seine-net fishing is now the means of supplying the greater part of the herrings for the consumer. Last year the 328 seine-boats, manned by 1382 men, landed 54,059 crans of herrings of the value of £70,325; while the 404 drift-boats, with 1262 men, landed only 15,965 crans, valued at £18,009.

The Mackerel of the East and West Coasts of Scotland.

Some years ago experiments were made at Barra with the view of ascertaining whether or not there was a likelihood of establishing a mackerel fishery in the adjoining seas, the results of which were described in a previous Report. In the present Report an account is given of an investigation by Mr. H. C. Williamson, made with the object of discovering whether the mackerel of the East and West Coasts were of the same or of different races. The mackerel examined were obtained from Barra, Stornoway, Lower Loch Fyne, Kilbrennan Sound, and off the coast of Aberdeen. A large number of measurements and observations were made on each of the fishes, and the means and their deviation calculated, and the results are set forth in a series of Tables appended to the paper. The general conclusion is that the differences in the length of the head, skull, and pectoral fin in the mackerel from the two coasts

may with some probability be granted racial distinction; while the remaining characters do not prove such differentiation.

The Fishes of the Firth of Clyde.

Mr. T. Scott furnishes in the present Report a list of the fishes which have been found within the limits of the Firth of Clyde, the information being derived from the investigations of the *Garland* and from several other sources. The number of species comprised in the list is 113, but the recorded occurrence of one or two of those appears to the author to be somewhat doubtful, and in the case of one or two other species, though their presence in the Clyde seems to be fairly well attested, further information is desirable. By the use of fine-meshed nets on the *Garland*, it has been shown that some forms, such as the Argentine and Lumpenus, which were previously considered to be rare, are not uncommon in certain localities.

The Surface-Currents of the North Sea.

In the Fifteenth Annual Report a description was given of the experiments made for the purpose of determining the direction and rate of the currents in the North Sea, with reference specially to the transport of the pelagic eggs and larvæ of fishes. Similar experiments have since been undertaken in the English Channel and neighbourhood by the Marine Biological Association, and also by the Belgian authorities. In the present Report a further statement is given by Dr. Wemyss Fulton of the results derived from a study of the additional drift floats, amounting to 132, which have been recovered at later dates since the time mentioned. They were found on the coasts of Schleswig, Denmark, Sweden, and Norway, to as far north as the North Cape, the extreme point of Norway, and extending over 17 degrees of latitude.

The results confirm the conclusion previously reached that the current passes southwards along the east coasts of Scotland and England as far as the Wash, and then passes over to the Schleswig and Danish coasts and northwards to the Skagerack and the western coast of Norway.

The Natural History of the Plaice.

In this Report will be found a paper by Mr. H. M. Kyle dealing with certain problems connected with the natural history of the plaice. The research has been conducted by means of a large number of specimens from various parts of the North Sea, and it was specially directed to discover the variations and variability of the species. With respect to the average size of the plaice when first mature, it appears that in the southern part of the North Sea the female plaice first reaches maturity at a size between thirteen and fourteen inches, while the males reach maturity when between ten and eleven inches in length. In the northern part of the North

Sea the female does not reach maturity, on an average, until attaining a length of about 15½ inches, and the male on the average at a length of twelve to thirteen inches. The variability of the sexes, and variations due to growth are considered in detail; and with regard to the question of race-variability, it is shown that the North Sea plaice are divided into at least two groups by definite and distinct differences in structure. The plaice of the southerly North Sea are relatively more elongated and narrower, while those of the northern parts of the North Sea are relatively broader and shorter. The causes of their difference and variability are discussed, and the paper is illustrated by a number of tables and diagrams.

The Classification of Flat-Fishes.

A paper on this subject is also furnished by Mr. Kyle, in which the affinities and classification of the various species and genera of flat-fishes are considered in great detail. The species examined included the majority of the European forms, representatives of the chief genera of the American flat-fishes, and of the Indian, China, and Australasian seas. Their structure and distribution are described, and their natural affinities, as far as possible, determined. The paper, which is illustrated by two plates, embodies the results of a large amount of work, and forms a valuable addition to our knowledge of the subject with which it deals.

The Invertebrate Fauna.

Another paper is furnished by Mr. Thomas Scott, in which he gives additional observations on the crustacean fauna, and describes a number of species belonging to the various groups, which were for the most part obtained by the *Garland* in the seaward part of the Firth of Clyde and in Loch Fyne. Some of the Copepoda are new to science, and with regard to those previously recorded, further information has been obtained regarding their structure and distribution. The paper is illustrated by two plates.

ANGUS SUTHERLAND, *Chairman.*
D. CRAWFORD, *Deputy-Chairman.*
D'ARCY W. THOMPSON.
J. RITCHIE WELCH.
W. R. DUGUID.
L. MILLOY.
D. MEARNS.

WM. C. ROBERTSON, *Secretary.*

SCIENTIFIC REPORTS.

I. REPORT ON THE TRAWLING EXPERIMENTS OF THE "GARLAND," AND ON THE FISHERY STATISTICS RELATING THERETO.

INTRODUCTORY.

During last year the trawling investigations of the "Garland" were conducted in the Firth of Clyde and Loch Fyne, where the stations were examined in each month, except in February, March, April, and August. The work at each station consists in—(1) trawling along a selected line for a specified distance, determined usually by cross-bearings, all the fish caught being enumerated, measured, and recorded; (2) observations on the temperature, density, and transparency of the water, on the condition of the weather, &c.: (3) collections of the pelagic organisms floating in the water. The Tables relating to the chief of these investigations will be found appended to this Report. In addition, special observations were made on the occurrence and distribution of pelagic fish eggs and larvæ, on the distribution of immature and spawning fishes, on the migrations of fishes, and on various other questions.

The "Garland" was also employed in February, March, and a portion of April in procuring live plaice for the sea-fish hatchery at Dunbar, and in conducting an investigation into the condition of the clam bait beds in the Firth of Forth.

The fishery statistics which have been collected in the districts of the Moray Firth in connection with the trawling experiments there, and which show the quantities of the various kinds of fish caught by line fishermen within the closed waters in each month of the year, and for the whole year, with the respective averages per "shot" of the lines, are appended to this Report, and are discussed below. These statistics were collected by the Fishery Officers of the various districts, or by their correspondents. The trawling records were made by Mr. F. G. Pearcey, the naturalist on board the "Garland."

The Firth of Clyde.

The trawling stations in the Firth of Clyde were examined last year in January, May, June, July, September, October, November, and December, 117 hauls being made with the ordinary trawl-net. In addition to these, several hauls were made at night, and 117 with a fine-meshed shrimp trawl, partly at the ordinary stations and partly in other localities, for the purpose mainly of determining the distribution of immature fish. The Clyde stations are seventeen in number, and are situated as follows:—

Station I. lies off the east coast of Cantyre, in from about twelve to twenty fathoms of water, and extends from Davaar Island to near Ru Staffnage.

Station II. is placed further north in the Sound of Kilbrennan, in from nine to over twenty fathoms, between Pluck Point and Carradale Point.

Station III. is situated opposite to Station II., in Machry Bay, Arran, where the water ranges from about ten to over twenty fathoms in depth.

Station IV. lies off Pirn Mill, Arran, to the north of Station III., in from twenty-seven to thirty fathoms.

Station V. is placed in Whiting Bay, on the other side of Arran, in water from ten to twenty fathoms.

Station VI. lies to the south of Station I., beginning off Rhuad Point, Cantyre, and has a depth of from twenty to thirty fathoms.

Station VII. is placed off the Ayrshire Coast, opposite the village of Ballantrae, in water of from sixteen to twenty-four fathoms deep.

Station VIII. is situated to the south-west of Ailsa Craig, about midway between Sanda Island, Cantyre, and Bennan Head, and the depth of water is from about twenty-seven to thirty-three fathoms.

Station IX. lies to the north of the last station and to the west of Ailsa Craig, in from twenty-five to twenty-eight fathoms.

Station X. lies between Station IX. and the coast of Cantyre, in water about twenty-six fathoms deep.

Station XI. passes round Ayr Bay, and has a depth of about twenty fathoms.

Station XII. lies midway between Arran and the coast of Ayr, in water from about thirty-three to forty-four fathoms deep.

Stations XIII.–XVII. are situated in Upper Loch Fyne. XIII. extends from near Otter Spit to Gortans, and has a depth of from twenty-five to thirty fathoms; XIV. extends from near Gortans to Minard Castle, the depth being about the same as the last; XV. extends from Inverawe to Furnace, with a depth of thirty-three to forty fathoms; XVI. passes from near Strachur to Inveraray, the depth varying from about sixty to seventy fathoms; and Station XVII. lies at the head of the loch from Dunderawe to above Cairndow, in from ten to thirty-five fathoms.

The number of fishes captured in the regular hauls of the ordinary trawl at these stations last year numbered close upon 20,000, of which over 12,000 were flat-fishes. A feature of contrast with the condition in the East Coast areas is the comparative scarcity of plaice, and the great abundance of witches, which are most numerous at Stations XV., XII., and VIII. They comprised very nearly half of all the flat-fishes caught. Long rough dabs were also abundant; so that these two species combined formed about 81 per cent. of the total flat-fishes. The statistics of the various kinds of fish caught at the twelve stations in the Firth of Clyde during the year show that the average number of flat-fishes

per haul of the net was 103·7, the average number of round-fishes (cod, haddock, whiting, and gurnard) 34·7, and the average of fishes of all kinds 176·9. Among flat-fishes the average for plaice was 1·5, for lemon soles 7·2, for witch soles 41·7. Common dabs gave an average of 14·9, and long rough dabs an average of 36·5. Other species of flat-fishes were taken in small numbers, including, for all the hauls, a total of 60 black soles. Among round-fishes gurnards were most numerous, giving an average of 22·3 per haul. The average for cod was only 1, and for haddocks 2; whiting were somewhat more abundant, the average being 9·4. The average for skates of the various species was 6.

Comparison of the results obtained in the various years in which trawling investigations have been conducted in the Clyde shows that, taking all the stations together and all the kinds of fish, the average number per haul of the net has generally increased over the period comprised. In 1888 the general average was 109·7 per haul; in 1890 it was 99·5 per haul; in 1895 it was 113·4; in 1896 it was 120·7; in 1897, 112·5; in 1898, 189·3; and in 1899, 176·9. The averages for the two groups of flat-fishes and round-fishes show that there has been a fairly steady rise in the former and considerable fluctuation in the latter. The figures are as follows:—

	1888.	1890.	189 5.	1896.	1897.	1898	1899.
Flat-Fishes, -	61·2	61·1	64·7	75·5	84·8	94·7	103·7
Round-Fishes,	44·7	35·1	43·6	35·1	27·8	49·9	34·7

The increase in the average number of flat-fishes appears whether the figures for the whole year are taken or the comparison is restricted to the same months, with one exception, namely, December, when more fishes of all kinds, except common dabs, were taken in 1898 than in 1899.

Comparison of the statistics relating to the various species of flat-fishes shows that the increase over the period has been principally in witches and long rough dabs. The averages are as follows:—

	1888.	1890.	1895.	1896.	1897.	1898.	1899.
Plaice, - -	5·3	3·4	2·3	2·1	2·5	3·0	1·5
Lemon Soles, -	7·4	5·6	2·8	7·2	5·3	4·1	7·2
Witches,- -	12·7	19·7	25·7	35·9	47·1	36·5	41·7
Common Dabs,	23·8	13·8	14·0	15·7	12·7	13·6	14·9
Long Rough Dabs	5·3	17·7	20·0	15·1	16·8	37·3	36·5

The same result is shown when the averages of the comparable months are considered, with the exception of December 1898, witches and long rough dabs indicating a substantial increase and plaice a diminution. Common dabs appear also to have diminished in abundance.

The trawling investigations in Upper Loch Fyne were not commenced until 1896, and there is not, therefore, the same material for comparison

as with the Firth of Clyde. Among flat-fishes the predominant species are, as at the outer stations, witches and long rough dabs. Plaice, although not abundant, are found in greater numbers than in the Firth of Clyde; cod are also more numerous in the loch, while whitings and gurnards are less numerous. The general averages for flat-fishes, round-fishes, and the total of all kinds in the various years are as follows:—

	1896.	1897.	1898.	1899.
Flat-Fishes, - - -	70·5	83·1	81·4	129·9
Round-Fishes, - - -	8·2	9·8	12·7	14·1
Totals, - - -	81·1	100·8	101·9	145·3

As in the Firth of Clyde, witches and long rough dabs give an increased average per haul of the net, and plaice do not show the same diminution as at the outer stations. Inasmuch as the observations hitherto made in the Clyde comprise a comparatively small number of hauls, inferences as to changes in the relative abundance of the fishes in the closed area must be provisional.

The special statistics of the fish caught by line in the closed waters of the Moray Firth and landed on the adjoining coast have been collected for the past six years. The total quantities and the average weight per "shot" of the lines for each year in the various districts around the Moray Firth are as follows:—

District.	1894.		1895.		1896.		1897.		1898.		1899.	
	Cwts.	Average.	Cwts.	Average.	Cwts	Average.	Cwts.	Average.	Cwts.	Average.	Cwts.	Ave age
Wick, - -	19,008	2·47	23,009	4·03	31,556	5·40	44,258	6·16	31,383	6·49	28,116	5·10
Lybster, - -	4,408	4·91	3,977	3·77	4,241	2·87	7,118	4·22	4,438	3·26	4,309	1·39
Helmsdale, -	15,826	3·52	16,669	4·15	18,360	4·71	17,148	4·93	13,143	3·84	12,752	3·85
Cromarty, -	21,346	3·07	19,193	2·93	15,317	2·51	14,736	2·48	12,428	2·065	11,183	1·81
Findhorn, -	60,074	4·04	68,761	4·86	63,521	4·46	46,694	2·66	30,770	2·088	31,825	1·95
Buckie, - -	48,540	4·21	50,489	4·66	57,450	5·05	50,067	4·77	41,102	4·24	34,915	3·35
Banff, - -	49,292	2·94	76 491	4·77	66,471	3·82	61,329	3·70	36,057	2·13	26,675	2·40
Total, -	218,494	3·05	258,589	4·43	256,916	4·26	241,350	3·83	169,321	3·244	147,775	2·66

These figures refer only to the fish caught by line within the closed area and landed in the districts. The total quantities of line-caught fish, taken from without as well as from within the closed waters, and landed in each district in 1899 are as follows—the gross amount being 180,649 cwts., or 26,000 cwts less than in the previous year:—

Wick.	Lybster.	Helmsdale.	Cromarty.	Findhorn.	Buckie.	Banff.
58,990	4,309	12,752	11,183	31,825	34,915	26,675

Comparison of these totals with those given in the above Table shows that a very large proportion of the line-caught fish landed in these districts comes from the closed waters of the Moray Firth—namely, 147,775 cwts. out of the total of 180,649 cwts. In all the districts,

except Wick, the line-caught fish landed are returned as having been taken from these waters. In previous years this was the case with a few of the districts only, and this circumstance seems to show that the line-fishing is becoming more restricted in this area. In 1898 a small proportion of the line-caught fish landed in the districts of Banff, Buckie, and Findhorn were procured outside the closed area.

With regard to the fluctuations in the quantities captured by line in the Moray Firth in the various years, it will be observed that the gross quantity landed in 1899 is less than in any of the previous years, and that the average per "shot" of the line is also the lowest. The decrease in the quantity last year, as compared with 1898, amounted to 21,546 cwts.; as compared with 1895 the decrease is 110,814 cwts.; and each year since 1895 has shown a progressive falling-off in the quantity of line-caught fish landed. The average catch per "shot" of the line has also fallen in the same period. In 1895 it was 4·43 cwts.; in 1896 very nearly the same, 4·26 cwts.; in 1897, 3·83 cwts.; in 1898, 3·24 cwts.; and last year only 2·66 cwts. It does not appear that this diminution in the quantity of line-caught fish landed from the Moray Firth has been owing to special causes, since there occurred a similar decline on the southern part of the east coast as well as on the west coast of Scotland. Thus, while in 1898 the quantity of line-caught fish landed on the East Coast, other than the Moray Firth, amounted to 479,377 cwts., last year the quantity was 413,173 cwts., showing a decrease of 66,204 cwts. The figures for the whole East Coast are—for 1898, 686,695 cwts., and for 1899, 593,822 cwts.—a decrease of 92,873 cwts. In 1897 the quantity was 959,566 cwts., or 365,745 cwts. more than it was last year. Along the whole coast of Scotland the quantity of line-caught fish landed last year was 939,362 cwts., as compared with 1,058,994 cwts. in 1898 and 1,416,237 cwts. in 1897. It is evident, therefore, that the diminution in the Moray Firth represents a general change, and is in proportion to the diminution elsewhere. The decrease in the Moray Firth was common to all the districts, except Findhorn, which shows a slight improvement on the previous year. It was most marked in the districts of Banff, Buckie, and Wick. In Banff the total quantity was 26,675 cwts., as against 36,057 cwts. for the preceding year. In Buckie the total was 34,915 cwts., as compared with 41,102 cwts. in 1898; while in the Wick district the quantities for the two years were respectively 26,116 cwts. and 31,383 cwts. In the districts of Lybster, Helmsdale, and Cromarty the decrease was comparatively slight. The average weight per "shot" of the line also declined in all the districts, except in Helmsdale, where it was the same as in the previous year. In the Lybster district it fell from 3·26 in 1898 to 1·398 in 1899, which is the lowest average for any district in any of the years since 1894. Three of the districts had averages below 2 cwts. per "shot"—an average not represented in any previous year.

With respect to the various kinds of fish caught by line within the closed waters of the Moray Firth, the quantities and the average weight per "shot" for each of the six years are given in the following Table:—

FISH.	1894.		1895.		1896.		1897.		1898.		1899.	
	Cwts.	Average.	Cwts.	Average.	Cwts.	Average.	Cwts.	Average.	Cwts.	Average.	Cwts.	Ave age
Cod	32,571	0·52	47,646	0·81	64,663	1·07	79,731	1·26	56,208	1·07	52,753	0·9
Ling	2,169	0·035	2,937	0·005	3,868	0·062	3,544	0·056	2,567	0·049	2,883	0·0
Torsk	25	0·002	24	—	94	—	25	—	43	—	82	—
Saithe	6,120	0·09	5,083	0·087	10,636	0·17	11,761	0·18	14,881	0·28	9,383	0·1
Haddock	153,529	2·47	178,370	3·056	156,703	2·6	126,031	2·004	81,098	1·554	68,075	1·22
Whiting	5,845	0·094	5,114	0·087	4,836	0·08	3,319	0·052	1,535	0·029	1,323	0·02
Turbot	5	—	—	—	15	—	16	—	13	—	60	—
Halibut	254	0·004	403	0·007	691	0·011	707	0·011	730	0·013	762	0·01
Lemon Sole	—	—	—	—	19	—	14	—	1	—	6	—
"Flounder, Plaice, and Brill"	5,477	0·088	5,765	0·09	3,402	0·056	3,978	0·063	3,425	0·065	5,005	0·0
Conger	1,244	0·02	777	0·013	823	0·013	1,533	0·024	826	0·015	741	0·01
Skate	3,281	0·053	3,014	0·051	3,683	0·061	3,999	0·063	3,273	0·062	3,584	0·0
Other kinds	7,976	0·128	9,456	0·16	7,483	0·12	6,663	0·105	4,574	0·087	3,116	0·0

More than four-fifths of the total quantity caught by line within the area consisted of cod and haddocks, and both of these show a diminution as compared with the previous year. The decrease in cod was comparatively slight, amounting for the year to 3415 cwts.—the average catch falling from 1·07 to 0·95 cwts. This decrease was common to all the districts, except Lybster and Findhorn. When the statistics for each of the six years are examined it is seen that there was a gradual rise both in the gross quantity and in the average per "shot" from 1894 to 1897, and since then a decline.

The averages for each district in each year are as follows .—

DISTRICT.	1894.	1895.	1896.	1897.	1898.	1899.
Wick,	0·99	1·83	3·22	4·16	3·23	2·75
Lybster,	1·92	1·79	1·71	2·47	1·89	0·88
Helmsdale,	0·75	1·31	2·01	2·39	1·90	1·57
Cromarty,	0·59	0·617	0·74	0·61	0·63	0·51
Findhorn,	0·48	0·75	0·85	0·52	0·55	0·61
Buckie,	0·55	1·0	1·3	1·68	1·34	1·21
Banff,	0·13	0·2	0·22	0·41	0·53	0·44

In all the districts the average shows a decline from the previous year, except in the district of Findhorn, where a slight increase occurred in the averages as well as in the total quantity.

The diminution of the quantity of haddocks caught by line in the Moray Firth is still more noteworthy. In 1898 the quantity landed was 81,098 cwts., while last year it was only 68,075 cwts., or a falling-off of nearly 14,000 cwts. The average per "shot" also declined from 1·554 to 1·229 cwts. The fluctuations in the abundance of this important food fish from year to year have been very considerable. In 1894 the quantity caught by line in the Moray Firth was 153,529 cwts.; in 1895 it rose to 178,370 cwts., and since then it declined to 156,703 cwts. in 1896, to 126,031 cwts. in 1897, to 81,098 cwts. in 1898, and to 68,075 cwts. last year. The average per "shot" has varied in much the same way. In 1894 it was 2·47 cwts.; in 1895, 3·056 cwts.; in 1896, 2·6 cwts.; in 1897, 2·0 cwts.; in 1898, 1·554 cwts.; and last year 1·229 cwts., or little more than a third of what it was in 1895. The decrease last year as compared with the previous year took place in

all the districts, with the exception of Helmsdale. In Banff district the quantity landed fell from 23,637 cwts. to 17,939 cwts., and the average from 1·93 to 1·61; in Buckie district the corresponding decline in the quantity was from 24,161 cwts. to 19,518 cwts., and the average fell from 2·49 to 1·87. In the Findhorn district the diminution was not so marked—namely, in quantity from 19,772 cwts. to 18,300 cwts., and in the average from 1·34 to 1·12.

The average weight of haddocks caught per "shot" of the line in each of the districts in the various years is as follows:—

District.	1894.	1895.	1896.	1897	1898.	1899.
Wick, - -	0·54	0·508	0·22	0·19	0·27	0·13
Lybster, - -	1·63	1·29	0·69	1·028	0·77	0·24
Helmsdale. - -	2·16	2·11	2·2	1·59	1·33	1·52
Cromarty, - -	2·18	1·96	1·51	1·54	1·10	0·95
Findhorn, - -	3·31	3·73	3·32	1·92	1·34	1·12
Buckie, - -	3·178	3·19	3·16	2·62	2·49	1·87
Banff, - - -	2·47	4·07	3·06	2·82	1·93	1·61

The next most abundant line-caught fish is the saithe or coal-fish, which, unlike the cod and the haddock, was obtained in gradually increasing quantities until last year. The quantity increased from 5083 cwts. in 1895 to 14,881 cwts. in 1898, the average per "shot" also rising in the same period from 0·087 to 0·28. Last year, however, the quantity fell to 9383 cwts., and the average to 0·169; and the decline was common throughout the Firth generally, all the districts showing a diminution both in the gross quantity landed and in the catch per shot of the line. The decrease was most marked in the districts of Wick and Banff. In the former, the quantity diminished from 9292 cwts. to 6330 cwts.; in the latter, from 2,597 cwts. to 850 cwts.

It is somewhat remarkable that throughout the period of six years there has been a progressive diminution in the abundance of whitings, which are chiefly caught in the Banff and Findhorn districts. In 1894 the quantity landed was 5845 cwts., the average per "shot" being 0·094 cwts.; last year the gross quantity was only 1323 cwts., and the average per "shot" 0·023 cwts. The decline has been fairly steady from year to year.

The quantity of conger landed in 1899 was but little below the total for the previous year, the figures being 741 and 826 cwts. respectively. There was, on the other hand, a slight increase in the quantity of skates—from 3273 to 3584 cwts.—but the averages were practically the same in the two years. The statistics for these fishes, indeed, show greater uniformity from year to year than in the case of any others. Of "other kinds of white fish" caught by line, besides those specified in the Tables, there was a decrease from 4574 to 3116 cwts., the average also declining from 0·087 to 0·056. In 1895 the quantity was 9456 cwts., and the average 0·16 and since then there has been a gradual decline.

Among flat-fishes, which, with the exception of the smaller forms in the group included under the heading "flounder, plaice, and brill," are not caught in great numbers by line in the Moray Firth, the statistics show that there was an increase last year as compared with the previous

year. The total weight of those landed in 1898 was 4169 cwts., as compared with 5833 cwts. in 1899. Very few lemon soles are caught by line, the total quantity last year amounting to six cwts., while in 1898 only one cwt. were landed. Turbot increased from 13 cwts. in 1898 to 60 cwts. last year, and halibut from 730 to 762 cwts., although the average per "shot" remained the same. Among "flounder, plaice, and brill," the increase was from a total quantity of 3425 cwts. in 1898, to 5005 cwts. last year, the respective averages being 0·065 and 0·09; and this increase took place almost entirely in the three districts of Helmsdale, Cromarty, and Findhorn. The whole of the turbot included in the returns were landed in the Wick district.

The quantities of flat-fishes landed in each of the years and the percentages of the total are as follows:—

	1894.	1895.	1896.	1897.	1898.	1899.
Cwts. - - -	5736	6170	4127	4715	4169	5833
Percentage of Total Catch, - -	2·6	2·3	1·6	1·9	2·5	3·9

The total quantity captured last year corresponds closely to the total in 1894, but the percentage is considerably higher, and is the highest in the series. The average weight per "shot," which was greatest in 1895 and lowest in 1896, has gradually increased since the latter year.

When we compare the fluctuations in the quantities of the fish caught by line in the Moray Firth with the corresponding statistics for the whole East Coast, and the whole of Scotland, it is found that the changes have been general, and not characteristic of the area named. The diminution in the abundance of cod and haddocks was common to the rest of the coast. The quantity of cod landed on the east coast of Scotland in 1898 amounted to 263,838 cwts., while last year it was 232,922 cwts.—a decrease of 30,916 cwts. In the other districts on the East Coast outside the Moray Firth the quantities were in 1898, 185,730 cwts., and in 1899, 160,321 cwts., or a reduction of 25,409 cwts. For the whole of Scotland the corresponding figures are 390,589 cwts. in 1898 and 321,669 cwts. in 1899—a falling-off of 68,920 cwts. So also with haddocks. In 1898 the quantity landed on the whole East Coast was 240,306 cwts., as compared with 181,397 last year—a difference of 58,909 cwts. In the districts on the East Coast south of the Moray Firth, the quantity landed in 1898 was 156,330 cwts., and in 1899, 111,544 cwts., showing a decrease of 44,786 cwts. in the latter year. On the whole coast of Scotland the decrease in the quantity of haddocks landed last year amounted to 62,116 cwts. The same is true in regard to saithe, the diminution noticed in the statistics from the Moray Firth being common to other parts of the East Coast. With respect to flat-fishes also, we find that there occurred a slight increase in the quantity landed last year as compared with the year before, not only in the Moray Firth, but on the other parts of the East Coast; although, in this case, the increase in the Moray Firth seems to be relatively greater. The quantity landed in the districts to the south of the Moray Firth in 1898 was 25,944 cwts., while last year the quantity amounted to 26,184 cwts.—an increase of 240 cwts. Within the Moray Firth the quantity landed from the closed waters was 4169

cwts. in 1898 and 5833 cwts. in 1899, showing an increase of 1664 cwts.

An examination of the statistics dealing with the number of "shots" of the line-fishing boats in the Moray Firth—that is, the number of visits to the fishing grounds—shows that during last year there was an increase in the case of both the large boats and the small boats as compared with the previous year. The figures for the whole of the Moray Firth in each of the six years are these:—

	1894	1895	1896	1897	1898	1899
Large Boats, . .	7,082	7,710	11,915	14,039	10,330	12,665
Small Boats, . .	54,866	50,643	48,346	48,836	41,853	42,808
	61,948	58,353	60,261	62,875	52,183	55,473

It will be observed that while the number of "shots" of the small-line boats has steadily declined over the period, the number of "shots" of the great-line boats increased from 1894 to 1897, and that the considerable fall in 1898 was partly made up last year. On the whole, however, line-fishing in the Moray Firth has declined during the last two years. The detailed statistics for each of the districts are as follows:—

Year.	Wick.		Lybster.		Helmsdale.		Cromarty.		Findhorn.		Buckie.		Banff.	
	Large.	Small.	Large.	Small.	Large.	Small.	Large.	Small.	Large.	Small.	Large.	Small.	Large.	Small.
1894	396	7,295	22	876	199	4,288	83	6,871	3,132	10,544	2,422	9,104	828	15,888
1895	1,553	4,155	90	965	366	3,614	12	6,561	2,653	11,481	1,929	8,907	1,107	14,930
1896	2,774	3,063	208	1,266	363	3,535	13	6,078	3,772	10,450	2,935	8,420	1,850	15,534
1897	3,911	3,266	264	1,440	460	3,010	3	5,918	4,738	12,810	2,537	7,943	2,120	14,449
1898	1,918	2,846	148	1,211	448	2,971	2	6,015	4,148	10,577	1,958	7,727	1,708	10,506
1899	1,865	3,249	1,932	1,149	382	2,940	61	6,146	5,377	10,883	1,940	8,476	1,108	9,975

In the Cromarty and Findhorn districts, the number of "shots" of both great and small-line boats increased; in Banff and Helmsdale districts there was a decrease in both; in Buckie and Wick districts the "shots" of large-line boats slightly decreased and those of small-line boats increased; and in Lybster district there was a great increase in the "shots" of the large line-boats and a slight decrease in those of the small-line boats. It may be added that the operations of a considerable number of foreign trawlers within the Moray Firth during the past few years must materially affect the results of the trawling investigations there. In 1895 and 1896 a single foreign trawler was engaged in fishing in the Moray Firth; in the next year there were seven observed frequenting it; and the number increased to 32 in 1898, and to 52 in 1899.

T. WEMYSS FULTON,
Scientific Superintendent.

TABLE A.—Showing Summary of Fish taken by the 'Garland' in Trawling Operations in 1899.

Station and Date.	Flat-Fish.									Round-Fish.							
	Plaice.	Lemon Soles.	Witch Soles.	Common Dabs.	Long Rough Dabs.	Black Soles.	Scaldfish.	Sail-Flake.	Total.	Haddocks.	Whitings.	Gurnards.	Total.	Skate.	Other Fish.*	Total.
Firth of Clyde.																
Station I.																
May 30,	.	22	4	12	57	2	.	.	97	13	.	2	13	28	11	13	149
June 7,	3	5	.	.	7	.	.	.	15	.	2	.	2	4	.	156	175
July 6,	2	25	3	31	48	2	.	.	111	3	1	1	16	21	8	13	153
Sept. 1,	5	26	.	66	3	1	.	.	101	14	12	.	27	53	9	15	178
Oct. 5,	.	30	.	8	.	.	.	.	38	4	10	1	7	22	5	37	102
Nov. 10,	.	4	.	10	11	2	.	.	27	.	2	5	9	16	9	29	81
Dec. 14,	1	5	7	9	26	1	.	.	49	.	5	6	8	19	10	15	93
	11	117	14	136	152	8	.	.	438	34	32	15	82	163	52	278	931
Station II.																	
June 2,	3	.	.	27	40	.	.	.	70	.	5	.	6	11	2	4	87
July 6,	2	3	2	17	18	.	.	.	42	3	.	3	6	12	6	5	65
Sept. 1,	5	9	4	36	14	.	.	.	68	.	4	.	9	13	8	17	106
Oct. 5,	8	11	2	43	.	12	3	.	79	1	9	.	9	19	7	16	121
Nov. 9,	15	3	.	7	.	.	.	.	25	1	1	.	17	19	1	4	49
Dec. 14,	17	4	11	43	7	1	.	.	83	3	2	.	7	12	6	8	109
	50	30	19	173	79	13	3	.	367	8	21	3	54	86	30	54	537
Station III.																	
June 1,	.	18	118	2	115	.	.	.	253	.	1	52	1	54	4	95	406
July 4,	.	3	92	.	95	.	.	.	190	1	.	20	.	21	4	69	284
Sept. 5,	1	35	55	123	50	.	.	.	264	1	6	2	15	24	5	129	422
Oct. 4,	11	10	36	45	33	2	.	.	*138	6	5	4	28	43	5	112	298
Nov. 9,	2	6	6	81	7	1	.	.	103	4	2	1	7	14	3	6	126
Dec. 5,	.	19	38	67	16	2	.	.	142	2	.	.	43	45	11	23	221
	14	91	345	318	316	5	.	.	1090	14	14	79	94	201	32	434	1757
Station IV.																	
June 2	.	2	12	4	11	.	.	.	29	.	1	1	2	4	2	.	35
July 6,	.	18	13	3	18	.	.	.	52	.	1	.	8	9	4	6	71
Sept. 2,	.	9	4	2	34	.	.	.	49	2	9	.	22	33	4	11	97
Oct. 4,	.	13	.	40	.	.	.	.	53	1	7	.	1	9	7	87	156
Nov. 9,	.	7	.	32	.	1	.	.	40	.	.	.	1	1	1	.	42
Dec. 5,	.	9	.	17	.	2	.	.	28	.	.	.	3	3	.	1	32
	.	58	29	98	63	3	.	.	251	3	18	1	37	59	18	105	433
Station V.																	
June 1,	1	8	2	8	26	.	.	.	45	.	.	.	5	5	2	4	56
July 4,	3	27	.	15	48	.	2	.	95	.	.	.	5	5	1	8	109
Sept. 8,	.	17	.	29	.	.	.	.	46	.	4	.	2	6	.	192	244
Oct. 11,	.	17	.	41	1	.	.	.	59	.	1	.	7	8	7	11	85
Nov. 17,	.	15	.	46	1	.	.	.	62	.	.	.	8	8	.	3	73
Dec. 18,	.	6	2	17	6	.	.	.	31	.	1	.	12	13	1	6	51
	4	90	4	156	82	.	2	.	338	.	6	.	39	45	11	224	618

* Including 1 brill.

TABLE A.—SHOWING SUMMARY OF FISH TAKEN BY THE 'GARLAND' IN TRAWLING OPERATIONS IN 1899—*continued.*

Station and Date.	Flat-Fish.								Round-Fish.					Skate.	Other Fish.	Total.
	Plaice.	Lemon Soles.	Witch Soles.	Common Dabs.	Long Rough Dabs.	Black Soles.	Scald Fish.	Sail Fluke.	Total.	Cod.	Haddocks.	Whitings.	Gurnards.	Total.			
FIRTH OF CLYDE—*continued.*																	
Station VI.																	
May 30,	1	31	.	40	4	.	.	.	76	.	2	5	23	30	21	19	146
June 7,	.	14	2	1	1	.	.	.	†19	4	.	.	3	7	6	7	39
July 7,	1	45	.	28	.	.	.	.	74	6	1	.	11	18	18	40	150
Sept. 6,	.	35	.	25	.	1	.	.	61	5	4	.	21	30	16	31	138
Oct. 5.	.	33	.	4	.	.	1	.	38	1	.	.	11	12	14	10	74
Nov. 14,	.	7	.	16	.	6	.	.	29	3	9	21	30	63	20	20	132
Dec. 6,	.	8	.	61	.	9	.	.	78	1	7	1	91	100	23	5	206
	2	173	2	175	5	16	1	.	375	20	23	27	190	260	118	132	885
Station VII.																	
Jan. 17,	3	.	87	13	7	1	.	.	111	.	4	27	6	37	7	6	161
May 29,	.	2	61	3	3	.	.	.	69	1	1	16	17	35	5	11	120
June 7,	.	1	44	3	7	.	.	.	55	.	1	8	23	32	4	26	117
July 7,	.	.	61	5	16	.	1	.	83	.	1	12	10	23	1	6	113
Sept. 12,	.	15	6	35	.	.	1	.	57	.	.	.	42	42	15	38	152
Oct. 6,	.	1	7	11	.	.	2	.	21	.	1	.	8	9	18	10	58
Nov. 15,	.	1	18	1	.	1	.	.	21	1	.	.	8	9	10	7	47
Dec. 12,	.	.	.	.	4	.	.	.	4	.	.	.	1	1	6	1	12
	3	20	284	71	37	2	4	.	421	2	8	63	115	188	66	105	780
Station VIII.																	
May 29,	.	2	239	.	3	1	.	7	*253	.	.	2	63	65	7	25	350
June 8,	.	.	145	2	8	.	1	1	157	.	.	2	23	25	3	42	227
July 7,	.	.	117	.	5	.	1	2	125	.	.	7	22	29	3	9	166
Sept. 13,	.	.	105	.	4	.	.	10	119	.	.	1	20	21	10	1	151
Oct. 10,	.	1	.	.	.	.	.	16	17	.	.	1	117	118	7	204	346
Nov. 23,	.	.	47	.	.	.	1	3	*52	.	.	11	15	26	5	17	100
Dec. 12,	.	.	18	.	.	.	3	8	29	.	.	5	21	26	.	24	79
	.	3	671	2	20	1	6	47	752	.	.	29	281	310	35	322	1419
Station IX.																	
Jan. 17,	1	.	37	13	3	1	.	.	55	.	.	50	31	81	6	49	191
May 29,	.	.	88	.	9	.	.	1	98	1	.	.	23	24	2	36	160
June 8,	.	1	143	.	14	.	.	.	158	.	.	2	20	22	3	17	200
July 8,	.	.	140	2	33	.	.	2	177	.	.	4	33	37	6	24	244
Sept. 8,	.	.	14	.	1	.	.	2	17	.	.	68	13	81	2	5	105
Oct. 10,	.	.	28	.	.	.	.	1	29	.	.	13	4	17	3	3	52
Nov. 15,	.	.	43	.	.	.	.	1	44	.	.	3	26	29	3	55	131
Dec. 13,	.	.	38	.	.	.	.	1	39	.	.	5	39	44	.	5	88
	1	1	531	15	60	1	.	8	617	1	.	145	189	335	25	194	1171
Station X.																	
Jan. 16,	.	2	64	2	7	4	.	.	79	.	18	130	.	148	7	124	358
May 30,	.	5	31	2	67	2	1	.	†109	.	.	1	15	16	8	16	149
June 13,	.	5	33	3	61	2	.	.	104	.	1	4	45	50	14	20	188
July 19,	.	2	71	.	42	1	3	1	120	.	.	17	35	52	9	28	209
Sept. 6,	.	1	.	.	5	.	.	.	6	.	26	51	140	217	21	99	343
Oct. 9,	.	.	.	2	.	.	.	.	2	.	.	.	29	29	6	4	41
Nov. 14,	.	.	21	.	.	.	1	2	24	1	.	2	29	32	3	23	82
Dec. 6,	.	.	76	3	12	.	1	.	92	.	.	4	61	65	6	52	215
	.	15	296	12	194	9	6	3	536	1	45	209	354	609	74	366	1585

* Including 1 brill. † Including 1 turbot

TABLE A.—Showing Summary of Fish taken by the 'Garland' in Trawling Operations in 1899—*continued.*

Station and Date.	Flat-Fish.									Round-Fish.					Skate.	Other Fish.	Total.
	Plaice.	Lemon Soles.	Witch Soles.	Common Dabs.	Long Rough Dabs.	Black Soles.	Scaldfish.	Tail-Fluke.	Total.	Cod.	Haddocks.	Whitings.	Gurnards.	Total.			
Firth of Clyde—*continued.*																	
Station XI.																	
Jan. 24,	22	7	69	62	82	1	.	.	*244	.	1	2	30	33	1	10	288
June 1,	.	2	29	2	112	.	.	.	145	1	1	5	2	9	6	14	174
July 4,	.	.	37	.	119	.	.	.	156	.	.	16	19	35	2	13	206
Sept. 15,	4	.	82	3	76	.	.	.	165	.	.	27	64	91	1	21	278
Oct. 12,	2	.	45	14	32	.	.	.	93	.	.	2	8	10	3	24	130
Nov. 20,	6	2	78	11	75	.	.	.	172	.	.	2	102	104	5	31	312
Dec. 15,	2	.	69	3	9	.	.	.	83	.	.	3	21	24	3	48	158
	36	11	409	95	505	1	.	.	1058	1	2	57	246	306	21	161	1546
Station XII.																	
Jan. 20,	14	.	108	.	405	1	.	.	513	1	.	8	1	10	6	47	578
May 31,	.	.	38	.	192	.	.	.	230	1	.	17	1	19	2	23	274
June 17,	.	.	53	.	303	.	.	.	356	.	.	7	.	7	4	15	382
July 24,	1	.	50	.	218	.	.	.	269	.	1	51	12	64	3	32	368
Sept. 14,	3	1	157	.	173	.	.	.	334	.	.	17	78	95	3	57	489
Oct. 12,	1	.	223	.	126	.	.	.	350	.	.	8	18	26	.	61	437
Nov. 25,	1	.	179	1	76	.	.	.	257	.	.	27	10	37	2	97	393
Dec. 18,	.	.	93	.	61	.	.	.	154	.	.	25	69	94	2	32	282
	7	1	901	1	1554	1	.	.	2465	2	1	160	189	352	22	364	3203
Station XIII.																	
May 26,	9	3	14	3	74	.	.	.	103	13	15	.	10	38	1	18	160
June 20,	7	1	12	4	30	1	.	.	55	9	7	1	4	21	1	12	89
July 27,	7	.	4	6	48	.	.	.	65	4	10	3	10	27	.	4	96
Sept. 27,	.	1	1	4	46	.	.	.	52	4	.	.	39	43	2	4	101
Oct. 18,	.	.	.	1	19	.	.	.	20	3	2	2	8	15	1	8	44
Nov. 27,	.	.	1	.	15	.	.	.	16	3	1	.	7	11	2	47	76
Dec. 20,	.	3	5	.	11	.	.	.	19	4	4	.	.	8	4	21	52
	23	8	37	18	243	1	.	.	330	40	39	6	78	163	11	114	618
Station XIV.																	
May 26,	5	1	23	5	37	.	.	.	71	5	3	1	4	13	.	9	93
June 20,	2	2	12	1	15	.	.	.	32	7	13	2	11	33	.	9	74
July 27,	3	.	25	2	74	.	.	.	104	9	4	.	3	16	.	15	135
Sept. 27,	.	3	2	2	5	.	.	.	12	10	4	.	3	17	3	21	53
Oct. 18,	.	.	.	.	37	.	.	.	37	.	2	5	6	13	.	20	70
Nov. 27,	.	1	1	.	9	.	.	.	11	17	13	2	11	43	1	54	109
Dec. 21,	.	.	26	.	19	.	.	.	45	.	1	6	9	16	.	8	69
	10	7	89	10	196	.	.	.	312	48	40	16	47	151	4	136	603
Station XV.																	
June 21,	1	.	239	.	135	.	.	.	375	1	3	.	.	4	1	4	384
July 27,	1	.	82	.	115	.	.	.	198	5	2	3	2	12	1	27	238
Sept. 28,	18	.	374	26	246	.	.	.	664	3	1	.	2	6	.	7	677
Oct. 18,	16	.	160	.	231	.	.	.	407	3	9	2	1	15	3	55	480
Nov. 27,	4	.	83	.	59	.	.	.	146	10	4	1	.	15	3	8	172
Dec. 21,	3	.	165	.	35	.	.	.	203	.	3	4	7	14	1	6	224
	43	.	1103	26	821	.	.	.	1993	22	22	10	12	66	9	107	2175

* Including 1 brill.

TABLE A.—Showing Summary of Fish taken by the 'Garland' in Trawling Operations in 1899—*continued.*

Station and Date.	Flat-Fish.									Round-Fish.					Skate.	Other Fish.	Total.
	Plaice.	Lemon Soles.	Witch Soles.	Common Dabs.	Long Rough Dabs.	Black Sole.	Scaldfish.	Sail-Fluke.	Total.	Cod.	Haddocks.	Whitings.	Gurnards.	Total.			
Firth of Clyde—*continued.*																	
Station XVI.																	
May 27, .	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	1
June 22, .	.	.	170	.	.	.	.	.	170	.	2	.	.	2	.	1	173
July 26, .	.	.	5	.	.	.	.	.	5	.	1	.	.	1	.	.	6
Sept. 28, .	.	.	3	.	3	.	.	.	6	.	1	.	.	1	.	1	8
Oct. 19, .	.	.	105	.	5	.	.	.	110	.	16	.	.	16	.	3	129
Nov. 28, .	.	.	18	.	13	.	.	.	31	1	.	.	.	1	.	1	33
	.	..	302	.	21	.	.	.	323	1	20	.	.	21	.	6	350
Station XVII.																	
May 27, .	12	4	26	11	17	.	.	.	70	2	1	.	8	11	1	2	84
June 23, .	7	1	46	.	29	.	.	.	83	5	.	2	1	8	1	2	94
July 26, .	6	.	113	2	72	.	.	.	193	10	2	1	4	17	1	6	217
Sept. 29, .	2	.	79	2	39	.	.	.	122	2	2	2	4	10	3	6	141
Oct. 24, .	18	3	145	9	144	.	.	.	319	5	.	4	4	13	2	6	340
Nov. 28, .	7	1	49	.	29	.	.	.	86	1	3	.	.	4	.	6	96
Dec. 21, .	1	.	28	.	38	.	.	.	67	.	.	.	.	.	2	8	77
	53	9	486	24	368	.	.	.	940	25	8	9	21	63	10	36	1049

TABLE B.—ANALYSIS OF THE 'GARLAND'S' STATISTICS RELATING TO THE RELATIVE ABUNDANCE OF FISH.

Station.	Flat-Fish.									Round-Fish.					Skate.	Other Fish.	
	Plaice.	Lemon Soles.	Witch Soles.	Common Dabs.	L. Rough Dabs.	Black Sole.	Scaldfish.	Sail-Fluke.	Total.	Cod.	Haddocks.	Whitings.	Gurnards.	Total.			
									Firth of Clyde.								
I.	1·6	16·7	2·0	19·4	21·7	1·1	–	–	62·6	4·9	4·6	2·1	11·7	23·3	7·4	39·7	13
II.	8·3	5·0	3·2	28·8	13·2	2·2	0·5	–	61·2	1·3	3·5	0·5	9·0	14·3	5·0	9·0	8
III.	2·3	15·2	57·5	53·0	52·7	0·8	–	–	181·7	2·3	2·3	13·2	15·7	33·5	5·3	72·3	29
IV.	–	9·7	4·8	16·3	10·5	0·5	–	–	41·8	0·5	3·0	0·2	6·2	9·8	3·0	17·5	7
V.	0·7	15·0	0·7	26·0	13·7	–	0·3	–	56·3	–	1·0	–	6·5	7·5	1·8	37·3	10
VI.	0·3	24·7	0·3	25·0	0·7	2·3	0·1	–	53·6	2·9	5·3	3·9	27·1	37·1	16·9	18·9	12
VII.	0·4	2·5	35·5	8·9	4·6	0·2	0·5	–	52·6	0·2	1·0	7·9	14·4	23·5	8·2	13·1	9
VIII.	–	0·4	95·9	0·3	2·9	0·1	0·9	6·7	107·4	–	–	4·1	40·1	44·3	5·0	46·0	20
IX.	0·1	0·1	66·4	1·9	7·5	0·1	–	1·0	77·1	0·1	–	18·1	23·6	41·9	3·1	24·2	14
X.	–	1·9	37·0	1·5	24·2	1·1	0·7	0·4	67·0	0·1	5·6	26·1	44·2	76·1	9·2	45·7	19
XI.	5·1	1·6	58·4	13·6	72·1	0·1	–	–	151·1	0·1	0·3	8·1	35·1	43·7	3·0	23·0	22
XII.	0·9	0·1	112·6	0·1	194·2	0·1	–	–	308·1	0·2	0·1	20·0	23·6	44·0	2·7	45·5	40
XIII.	3·3	1·1	5·3	2·6	34·7	0·1	–	–	47·1	5·7	5·6	0·9	11·1	23·3	1·6	16·3	8
XIV.	1·4	1·0	12·7	1·4	28·0	–	–	–	44·6	6·9	5·7	2·3	6·7	21·6	0·6	19·4	8
XV.	7·2	–	183·8	4·3	136·8	–	–	–	332·2	3·7	3·7	1·7	2·0	11·0	1·5	17·8	36
XVI.	–	–	50·3	–	3·5	–	–	–	53·8	0·2	3·3	–	–	3·5	–	1·0	5
XVII.	7·6	1·3	69·4	3·4	52·6	–	–	–	134·3	3·6	1·1	1·3	3·0	9·0	1·4	5·1	14
Month.																	
January, .	5·4	1·8	73·0	18·0	100·8	1·6	–	–	200·8	0·2	4·6	43·4	13·6	61·8	5·4	47·2	31
May, . .	2·5	6·4	47·7	6·9	42·1	0·5	0·1	0·7	107·0	3·3	2·0	4·0	16·1	25·4	5·3	15·6	15
June, . .	1·4	3·5	62·3	3·3	53·8	0·2	0·06	0·06	124·8	1·6	2·2	5·1	8·7	17·5	3·1	25·2	17
July, . .	1·5	7·2	47·9	6·5	57·0	0·2	0·4	0·3	121·1	2·4	1·4	8·1	11·5	23·5	3·9	17·9	16
September, .	2·2	8·9	52·1	20·8	41·1	0·1	0·06	0·7	126·1	2·4	4·3	9·9	29·5	46·1	6·0	38·5	21
October, .	3·3	7·0	44·2	12·8	36·9	0·8	0·4	1·0	106·5	1·4	3·6	2·5	15·6	23·2	5·2	39·5	17
November, .	2·1	2·8	32·0	12·1	17·3	0·6	0·1	0·3	67·4	2·5	2·1	4·4	16·5	25·4	4·0	24·0	12
December, .	1·5	3·4	36·0	13·8	15·2	0·9	0·2	0·6	71·6	0·6	1·4	3·7	24·5	30·2	4·7	16·4	12

TABLE C.—Record of Observations made on Board the 'Garland' during 1899.

A. FISH CAUGHT—Firth of Clyde.

tation, ıle, and Time Trawl lown.	Kind of Fish.	Size in Inches.																			Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
ation I.																					
1899.																					
lay 30.	Red gurnard,	.	.	.	1	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	3
57 p.m.	Common gurnard,	.	1	2	5	3	.	.	1	.	.	1	.	.	.	.	.	.	.	.	13
to 32 p.m.	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*2
	John Dory,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
	Dragonet,	.	1	2	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
	Cod,	.	.	.	1	2	3	3	3	.	.	.	.	.	.	.	.	.	.	.	†13
	Brassie,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
	Whiting,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	.	.	2
	Long rough dab,	1	9	35	11	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	57
	Lemon sole,	.	2	4	1	5	1	1	4	.	1	2	1	.	.	.	.	.	.	.	22
	Witch sole,	.	.	.	.	.	.	.	.	.	2	2	.	.	.	.	.	.	.	.	4
	Common dab,	1	4	4	2	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	12
	Black sole,	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Argentine,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Thornback skate,	.	.	.	.	.	2	2	2	.	2	.	.	.	.	.	.	.	.	1	9
	Cuckoo ray,	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	2
																					149
ıne 7.	Common gurnard,	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	2
25 a.m.	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	‡1
to 55 a.m.	Haddock,	.	.	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	2
	Brassie,	7	17	32	52	36	4	1	.	.	.	.	.	.	.	.	.	.	.	.	149
	Hake,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	2
	Ling,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	‖1
	Long rough dab,	.	1	3	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7
	Plaice,	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	1	3
	Lemon sole,	.	.	1	1	.	.	1	.	.	2	.	.	.	.	.	.	.	.	.	5
	Conger,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	§1
	Nurse-hound,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	¶2
																					175
uly 6.	Common gurnard,	4	2	.	4	4	.	.	.	.	1	.	.	.	.	.	.	.	.	.	**16
0 p.m.	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	††2
to 5 p.m.	Dragonet,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Cod,	.	.	.	1	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Haddock,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1
	Brassie,	.	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Whiting,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
	Hake,	.	.	.	.	.	.	.	.	1	.	2	.	.	2	.	.	.	.	.	‡‡6
	Long rough dab,	.	7	17	21	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	48
	Plaice,	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	2
	Lemon sole,	1	10	5	4	1	.	2	.	1	1	.	.	.	.	.	.	.	.	.	25
	Witch sole,	.	.	.	.	.	.	1	.	.	.	.	1	1	.	.	.	.	.	.	3
	Common dab,	3	4	15	9	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	31
	Black sole,	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	2
	Thornback skate,	.	.	.	.	1	.	2	3	1	.	.	.	.	.	.	.	.	.	.	7
	Cuckoo ray,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
																					153

* 28 and 49 inches. † One 3 inches. ‡ 30 inches. ‖ 49 inches. § 53½ inches. ¶ 28 inches. ** One 3 inches.
†† 26 and 30 inches. ‡‡ One 28 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1899.

A. FISH CAUGHT—Firth of Clyde—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches. 4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	Total.
Station I.																						
Sept. 1. 11-15 a.m. to 0-40 p.m.	Common gurnard,	5	9	2	9	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	27
	John Dory,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
	Dragonet,	.	1	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Cod,	.	.	.	1	1	6	2	3	.	.	1	.	.	.	.	.	.	.	.	.	14
	Haddock,	.	.	.	.	5	3	.	.	.	.	.	.	1	2	1	.	.	.	.	.	12
	Brassie,	4	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7
	Hake,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
	Long rough dab,	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Plaice,	.	.	.	.	.	.	.	.	1	.	3	1	.	.	.	.	.	.	.	.	5
	Lemon sole,	.	2	5	8	1	.	3	2	3	2	.	.	.	.	.	.	.	.	.	.	26
	Common dab,	5	26	28	7	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	66
	Black sole,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
	Conger,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*2
	Nurse-hound,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
	Thornback skate,	.	.	.	.	.	1	1	2	3	1	.	.	.	.	1	.	.	.	.	.	9
																						178
Oct. 5. 2-20 p.m. to 4-8 p.m.	Red gurnard,	.	.	1	.	3	2	.	1	1	.	.	.	.	.	.	.	.	.	.	.	8
	Common gurnard,	.	.	1	.	4	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	7
	Cod,	.	.	.	.	.	2	.	.	.	1	.	.	.	.	.	.	1	.	.	.	4
	Haddock,	.	.	.	.	8	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	10
	Brassie,	.	17	10	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	29
	Whiting,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
	Lemon sole,	.	1	8	6	5	1	.	.	6	2	1	.	.	.	.	.	.	.	.	.	30
	Common dab,	.	3	2	2	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	8
	Thornback skate,	.	.	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	1	1	.	5
																						102
Nov. 10. 0-30 p.m. to 1-55 p.m.	Streaked gurnard,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
	Common gurnard,	.	.	3	3	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	9
	Haddock,	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Brassie,	.	8	12	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	20
	Whiting,	.	.	.	.	.	.	.	.	4	1	.	.	.	.	.	.	.	.	.	.	5
	Saithe,	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	2
	Hake,	.	.	.	.	.	.	.	.	.	.	1	.	1	.	2	1	.	.	.	.	5
	Long rough dab,	.	.	2	9	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11
	Lemon sole,	.	.	2	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	4
	Common dab,	1	5	2	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	10
	Black sole,	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Argentine,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Grey skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	†1
	Thornback skate,	.	.	.	.	.	.	2	2	.	1	1	.	.	.	1	.	.	.	.	.	7
	Cuckoo ray,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
																						81
Dec. 14. 0-5 p.m. to 1-35 p.m.	Common gurnard,	.	.	.	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8
	Haddock,	.	.	.	.	1	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
	Brassie,	.	7	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11
	Whiting,	.	.	.	.	.	.	.	2	3	.	1	.	.	.	.	.	.	.	.	.	6
	Hake,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	3
	Long rough dab,	.	.	12	11	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	26
	Plaice,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
	Lemon sole,	.	.	.	1	.	.	.	2	.	1	.	.	.	.	.	.	.	.	1	.	5
	Witch sole,	.	.	.	.	.	.	.	.	1	.	4	2	.	.	.	.	.	.	.	.	7
	Common dab,	.	.	4	4	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9
	Black sole,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
	Nurse-hound,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	‡1
	Thornback skate,	.	.	1	1	1	1	1	.	1	.	1	.	.	.	.	.	.	.	.	.	7
	Cuckoo ray,	.	.	.	.	.	.	.	.	.	2	1	.	.	.	.	.	.	.	.	.	3
																						93

* 53 and 58 inches. † 30 inches. ‡ 35 inches.

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' DURING 1899.

A. FISH CAUGHT—FIRTH OF CLYDE—*continued.*

tation, te, and Time Trawl lown.	Kind of Fish.	Size in Inches. 4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	Total.
tion II.																						
une 2.	Common gurnard,	.	1	.	2	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
20 p.m.	Haddock,	.	.	.	4	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
to	Brassie,	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
45 p.m.	Hake,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	2
	Long rough dab,	3	6	9	19	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	40
	Plaice,	.	.	.	.	.	.	.	1	1	.	1	.	.	.	.	.	.	.	.	.	3
	Common dab,	7	7	9	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	27
	Thornback skate,	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	2
																						87
July 6.	Common gurnard,	.	.	1	4	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	6
10 a.m.	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*1
to	Cod,	.	.	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
47 p.m.	Brassie,	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Whiting,	.	.	.	.	1	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	3
	Hake,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	2
	Long rough dab,	.	.	9	8	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	18
	Plaice,	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	2
	Lemon sole,	.	.	2	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	3
	Witch sole,	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	2
	Common dab,	4	8	4	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	17
	Thornback skate,	1	.	.	1	.	1	1	2	.	.	.	.	.	.	.	.	.	.	.	.	6
																						65
Sept. 1.	Common gurnard,	.	2	.	2	3	.	2	.	.	.	1	.	.	.	.	.	.	.	.	.	9
35 p.m.	Haddock,	.	.	1	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
to	Hake,	.	.	.	.	.	.	.	.	.	.	1	2	5	3	2	2	2	.	.	.	17
10 p.m.	Long rough dab,	1	2	3	6	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	14
	Plaice,	.	.	.	.	.	.	.	1	.	.	1	1	.	1	.	1	.	.	.	.	5
	Lemon sole,	.	.	2	2	2	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	9
	Witch sole,	.	.	.	1	1	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	4
	Common dab,	1	17	11	5	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	36
	Thornback skate,	.	.	.	.	3	1	2	1	.	.	.	.	.	.	.	.	.	.	1	.	8
																						106
Oct. 5.	Common gurnard,	.	2	3	1	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9
4 a.m.	Angler,	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	2
to	John Dory,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
36 a.m.	Dragonet,	.	2	1	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
	Cod,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
	Haddock,	.	.	.	.	1	3	2	.	.	1	.	1	1	.	.	.	.	.	.	.	9
	Hake,	.	.	.	.	.	.	.	.	.	.	.	.	1	1	2	3	.	.	.	.	7
	Scald-fish,	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Plaice,	.	.	.	1	.	.	.	1	.	1	4	1	.	.	.	.	.	.	.	.	8
	Lemon sole,	.	2	2	.	3	1	3	.	.	.	.	.	.	.	.	.	.	.	.	.	11
	Witch sole,	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	2
	Common dab,	.	6	18	12	5	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	43
	Black sole,	.	.	.	.	.	2	7	2	1	.	.	.	.	.	.	.	.	.	.	.	12
	Thornback skate,	.	.	.	1	1	2	.	3	.	.	.	.	.	.	.	.	.	.	.	.	7
																						121
Nov. 9.	Common gurnard,	.	8	5	2	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
30 p.m.	Dragonet,	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	17
to	Cod,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	2
37 p.m.	Haddock,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Hake,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
	Plaice,	.	.	.	.	.	.	.	.	5	4	2	1	.	1	1	.	.	.	1	.	1
	Lemon sole,	.	.	1	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	15
	Common dab,	.	1	3	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Grey skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	7
	Zeugopterus punctatus,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
																						49

* 35 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1899.

A. FISH CAUGHT—Firth of Clyde—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches. 4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	Total.
Station II.																						
Dec. 14.	Common gurnard,	.	.	1	4	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7
9-10 a.m.	Dragonet,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
to	Cod,	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
10-34 a.m.	Haddock,	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Hake,	.	.	.	.	.	.	.	.	.	.	.	1	1	1	2	2	.	.	.	.	7
	Long rough dab,	.	.	.	7	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7
	Plaice,	.	.	.	.	.	.	.	1	5	3	.	3	1	.	1	1	.	1	1	.	17
	Lemon sole,	.	.	.	.	2	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Witch sole,	.	.	.	.	.	.	.	.	2	2	4	2	1	.	.	.	.	.	.	.	11
	Common dab,	1	4	16	12	4	4	.	1	.	.	.	.	.	.	.	.	.	.	.	.	*43
	Black sole,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Grey skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	†3
	Thornback skate,	1	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
Station III.																						109
June 1.	Common gurnard,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
2-15 p.m.	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	‡2
to	Haddock,	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1
3-40 p.m.	Brassie,	.	.	3	1	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8
	Poor-cod,	.	44	10	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	54
	Whiting,	.	2	.	2	9	25	11	.	1	1	.	.	.	.	.	.	.	1	.	.	52
	Saithe,	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	2
	Hake,	.	.	.	.	.	.	.	.	.	2	1	3	1	2	.	.	.	1	9	8	‖28
	Long rough dab,	5	7	44	44	5	8	1	.	.	.	.	.	.	.	.	.	.	.	.	.	§115
	Lemon sole,	.	.	.	.	10	1	4	3	.	.	.	.	.	.	.	.	.	.	.	.	18
	Witch sole,	.	.	1	2	1	7	4	12	16	31	18	16	7	3	.	.	.	.	.	.	118
	Common dab,	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Argentine,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Grey skate,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	1	.	.	.	3
																						406
July 4.	Cod,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	¶1
1-47 p.m.	Brassie,	.	7	8	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	17
to	Poor-cod,	.	23	10	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	34
2 57 p.m	Whiting,	.	.	.	.	1	6	4	2	3	2	1	1	.	.	.	.	.	.	.	.	20
	Hake,	.	.	.	.	.	.	.	.	.	2	2	4	3	3	.	.	1	.	2	.	**18
	Long rough dab,	.	8	28	35	16	5	2	1	.	.	.	.	.	.	.	.	.	.	.	.	95
	Lemon sole,	.	.	.	.	.	1	.	.	1	.	.	.	.	1	.	.	.	.	.	.	3
	Witch sole,	.	.	.	.	.	2	5	7	10	9	23	25	5	6	.	.	.	.	.	.	92
	Grey skate,	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	2
	Fuller's ray,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	††1
																						284
Sept. 5.	Common gurnard,	1	1	3	4	3	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	15
3-55 p.m.	Dragonet,	.	1	2	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	‡‡8
to	Diminutive sucker,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	‖‖2
5-25 p.m.	Cod,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
	Haddock,	.	.	.	.	1	.	.	.	.	.	1	.	2	1	1	.	.	.	.	.	6
	Brassie,	.	9	26	9	7	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	53
	Poor-cod,	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Whiting,	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	2
	Hake,	.	.	.	.	.	.	.	.	.	2	3	5	11	8	9	5	.	.	8	.	§§60
	Long rough dab,	3	5	16	17	8	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	50
	Plaice,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Lemon sole,	1	7	18	4	.	2	2	1	.	.	.	.	.	.	.	.	.	.	.	.	35
	Witch sole,	.	.	2	10	10	2	8	5	16	1	1	.	.	.	.	.	.	.	.	.	55
	Common dab,	22	29	50	16	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	123
	Conger,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	¶¶1
	Piked dog-fish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	***3
	Thornback skate,	4	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
																						422

* One 2¾ inches. † One 38 inches. ‡ One 40 inches. ‖ One 35 inches. § One 3 inches. ¶ 28 inches.
** One 35 inches. †† 30 inches. ‡‡ One 8 inches. ‖‖ Two 1 inch. §§ Seven 26, one 28, one 35 inches.
¶¶ 40 inches. *** Two 30 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1899.

A. FISH CAUGHT—Firth of Clyde—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																			Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
Station III.																					
Oct. 4. 1-5 p.m. to 9-30 p.m.	Common gurnard,	.	.	.	4	4	7	2	5	2	.	3	1	.	.	.	.	.	.	.	28
	Cod,	.	.	.	.	1	.	2	1	2	.	.	.	.	.	.	.	.	.	.	6
	Haddock,	.	.	.	.	.	.	.	.	.	.	3	.	1	.	.	1	.	.	.	5
	Brassie,	.	2	9	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	13
	Whiting,	.	.	.	.	.	.	2	1	.	1	.	.	.	.	.	.	.	.	.	4
	Hake,	.	.	.	.	.	.	.	.	.	.	2	4	18	40	31	.	1	1	.	97
	Long rough dab,	.	3	10	17	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*33
	Brill,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1
	Plaice,	.	.	1	.	.	.	2	2	5	.	1	.	.	.	.	.	.	.	.	11
	Lemon sole,	.	4	4	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10
	Witch sole,	.	.	1	7	6	3	6	6	2	3	2	.	.	.	.	.	.	.	.	36
	Common dab,	3	14	16	8	2	1	1	.	.	.	.	.	.	.	.	.	.	.	.	45
	Black sole,	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	2
	Argentine,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Piked dog-fish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	†1
	Thornback skate,	.	.	.	1	.	1	.	.	1	.	.	1	.	.	.	.	.	.	.	‡5
																					298
Nov. 9. 11-3 a.m. to 1-50 p.m.	Red gurnard,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
	Common gurnard,	.	2	.	.	1	.	3	1	.	.	.	.	.	.	.	.	.	.	.	7
	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	2
	Cod,	.	.	.	.	1	.	1	.	1	.	.	1	.	.	.	.	.	.	.	4
	Haddock,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.	.	.	.	2
	Whiting,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
	Hake,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	.	.	.	3
	Long rough dab,	.	1	2	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7
	Plaice,	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	2
	Lemon sole,	.	.	2	1	2	.	.	1	.	.	.	.	.	.	.	.	.	.	.	6
	Witch sole,	.	.	.	.	3	2	.	.	.	.	1	.	.	.	.	.	.	.	.	6
	Common dab,	.	27	19	19	9	3	2	1	.	1	.	.	.	.	.	.	.	.	.	81
	Black sole,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
	Thornback skate,	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	2
	Cuckoo ray,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
																					126
Dec. 5. 9-41 p.m. to 2-17 p.m.	Common gurnard,	.	.	1	2	3	11	1	4	7	11	2	1	.	.	.	.	.	.	.	43
	John Dory,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	‖1
	Dragonet,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Cod,	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Brassie,	.	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
	Hake,	.	.	.	.	.	.	.	.	.	.	.	.	3	4	5	2	2	.	.	16
	Long rough dab,	1	1	2	9	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	16
	Lemon sole,	.	.	2	6	3	3	2	1	2	.	.	.	.	.	.	.	.	.	.	19
	Witch sole,	.	.	.	1	4	4	6	5	4	6	2	4	2	.	.	.	.	.	.	38
	Common dab,	3	17	26	10	2	4	2	3	.	.	.	.	.	.	.	.	.	.	.	67
	Black sole,	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	2
	White skate,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1
	Thornback skate,	.	3	4	1	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	10
																					221
Station IV.																					
June 2. 1-44 p.m. to 4-38 p.m.	Common gurnard,	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Haddock,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Whiting,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Long rough dab,	1	1	4	4	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11
	Lemon sole,	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Witch sole,	.	.	.	.	2	2	2	4	1	.	1	.	.	.	.	.	.	.	.	12
	Common dab,	.	.	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Thornback skate,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	§2
																					35

* One 3 inches. † 26 inches. ‡ One 28 inches ‖ 3 inches. § One 3 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1899.

A. FISH CAUGHT—Firth of Clyde—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches. 4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	Total.
StationIV.																						
July 6.	Com. gurnard,	.	2	3	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8
8-50 a.m.	Haddock,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
to	Brassie,	1	3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
9-40 a.m.	Long rough dab,	2	5	8	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	18
	Lemon sole,	.	1	6	6	2	1	.	1	1	.	.	.	.	.	.	.	.	.	.	.	18
	Witch sole,	.	.	.	3	2	2	2	.	2	.	.	2	.	.	.	.	.	.	.	.	13
	Common dab,	.	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Thornback skate,	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	2
	Cuckoo ray,	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	2
																						71
Sept. 2.	Com. gurnard,	.	4	6	8	1	.	.	2	1	.	.	.	.	.	.	.	.	.	.	.	22
7-0 a.m.	Dragonet,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
to	Dimin. sucker,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*1
7-50 a.m.	Cod,	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Haddock,	.	.	.	1	1	5	1	.	.	.	.	1	.	.	.	.	.	.	.	.	9
	Brassie,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Hake,	.	.	.	.	.	.	.	.	.	.	2	.	.	6	.	.	.	.	.	.	8
	Long rough dab,	15	4	12	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	34
	Lemon sole,	.	.	5	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9
	Witch sole,	.	.	.	.	2	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Common dab,	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Thornback skate,	.	.	1	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	†4
																						97
Oct. 4.	Com. gurnard,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
0-40 p.m.	Cod,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
to	Haddock,	.	.	.	.	1	3	2	1	.	.	.	.	.	.	.	.	.	.	.	.	7
1-20 p.m.	Hake,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	22	32	5	7	.	.	‡87
	Lemon sole,	.	3	4	3	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	13
	Common dab,	.	14	16	8	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	40
	Thornback skate,	.	.	1	.	.	3	.	.	.	2	.	.	.	.	.	.	.	.	.	.	6
	Cuckoo ray,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
																						156
Nov. 9.	Com. gurnard,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
9-24 a.m.	Lemon sole,	.	.	2	3	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7
to	Common dab,	.	9	10	4	4	4	1	.	.	.	.	.	.	.	.	.	.	.	.	.	32
10-10 a.m.	Black sole,	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1
	Thornback skate,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
																						42
Dec. 5.	Com. gurnard.	.	.	1	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1	3
10-57 a.m.	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1
to	Lemon sole,	.	.	1	1	2	3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	9
11-48 a.m.	Common dab,	.	3	4	9	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	17
	Black sole,	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	2
																						32
Station V.																						
June 1.																						
10-48 a.m.	Com. gurnard,	1	3	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
to	Dragonet,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
11-50 a.m.	Brassie,	.	.	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Long rough dab,	1	5	16	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	26
	Plaice,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
	Lemon sole,	.	1	3	2	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	8
	Witch sole,	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	2
	Common dab,	1	3	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8
	Thornback skate,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
	Cuckoo ray,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	§1
																						56

* 1 inch. †One 30 inches. ‡ Six 22, three 23, nine 24, three 26 inches. § 3 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1899.

A. FISH CAUGHT—Firth of Clyde—*continued.*

Station, Date, and Time Trawl Down.	Kind of Fish.	Size in Inches. 4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	Total
Station V.																						
July 4.	Com. gurnard,	.	4	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
10-0 a.m.	Dragonet,	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
to	Brassie,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
11-5 a.m.	Poor-cod,	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Hake,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	
	Long rough dab,	2	12	24	8	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*4
	Scald-fish,	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Plaice,	.	.	.	.	.	1	.	1	.	.	.	1	.	.	.	.	.	.	.	.	
	Lemon sole,	1	7	9	4	2	.	2	2	.	.	.	.	.	.	.	.	.	.	.	.	2
	Common dab,	1	6	7	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	†1
	Thornback skate,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
																						10
Sept. 8.	Com. gurnard,	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	
3-52 p.m.	Angler,	.	.	.	.	.	.	.	1	1	2	.	.	.	.	.	.	.	.	.	.	
to	Haddock,	.	.	.	1	2	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	
4-45 p.m.	Brassie,	8	127	45	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	18
	Lemon sole,	.	3	7	3	1	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Common dab,	1	13	12	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
																						24
Oct. 11.	Com. gurnard,	.	1	3	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
12 noon	Haddock,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
to	Hake,	.	.	.	.	.	.	.	.	.	.	.	.	6	1	.	3	.	.	1	.	1
1-5 p.m.	Long rough dab,	.	.	7	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Lemon sole,	.	1	7	8	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Common dab,	3	21	12	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Thornback skate,	.	.	.	.	1	.	2	.	.	.	.	.	.	.	1	.	.	.	.	.	
	Cuckoo ray,	.	.	.	.	1	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	
																						8
Nov. 17.	Com. gurnard,	.	.	3	5	.	.	.	.	.	2	.	.	1	.	.	.	.	.	.	.	
9-40 a.m.	Hake,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
to	Long rough dab,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
10-30 a.m.	Lemon sole,	.	.	2	7	2	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Common dab,	.	15	17	2	4	7	1	.	.	.	.	.	.	.	.	.	.	.	.	.	4
																						7
Dec. 18.	Com. gurnard,	.	.	9	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
2-45 p.m.	Angler,	.	.	.	.	.	.	.	.	2	.	.	1	1	.	.	.	.	.	.	.	
to	Dragonet,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
3-38 p.m.	Haddock,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Hake,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	
	Long rough dab,	.	.	4	.	2	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	
	Lemon sole,	.	.	.	3	.	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	
	Witch sole,	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	
	Common dab,	.	.	12	.	2	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Curkoo ray,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	
Station VI.																						5
May 30.	Red gurnard,	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
11-32 a.m	Com. gurnard,	.	.	2	6	9	3	1	.	1	.	1	.	.	.	.	.	.	.	.	.	2
to	Dragonet,	.	.	3	2	4	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
1-15 p.m.	Haddock,	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Whiting,	.	.	.	.	1	.	1	.	3	.	.	.	.	.	.	.	.	.	.	.	
	Hake,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	‡
	Long rough dab,	.	.	1	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Plaice,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	
	Lemon sole,	.	6	12	6	1	2	1	1	1	.	1	.	.	.	.	.	.	.	.	.	3
	Common dab,	1	12	22	2	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Nurse-hound,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8
	Grey skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	
	Thornback skate,	.	.	.	1	.	.	.	.	6	3	4	2	.	.	.	.	.	.	.	1	1
	Cuckoo ray,	.	.	.	.	.	.	1	.	1	.	.	.	1	.	.	.	.	.	.	.	
																						14

* One 3 inches † One 3 inches. ‡ One 28 inches. § One 28 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1899.

A. FISH CAUGHT—Firth of Clyde—*continued.*

Station, Date, and Time Trawl Down.	Kind of Fish.	Size in Inches. 4+	5+	6+	7+	8+	9+	10+	11+	12+	13+	14+	15+	16+	17+	18+	19+	20+	21+	23+	25+	Total.
Station VI.																						
June 7. 9-51 p.m. to 2-30 p.m.	Red gurnard,	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	1
	Com. gurnard,	.	.	.	.	1	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	3
	John Dory,	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	1	.	.	.	.	3
	Cod,	.	.	.	.	1	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	4
	Hake,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
	Long rough dab,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Turbot,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*1
	Lemon sole,	.	.	5	3	1	.	.	.	1	3	.	1	.	.	.	.	.	.	.	.	14
	Witch sole,	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Common dab,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Nurse-hound,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	†2
	Cuckoo ray,	.	.	.	1	1	.	.	.	1	.	.	.	3	.	.	.	.	.	.	.	6
																						39
July 7. 8-30 a.m. to 10-15 a.m.	Red gurnard,	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	1	.	1	.	4
	Com. gurnard,	.	1	.	2	5	.	1	1	.	.	1	.	.	.	.	.	.	.	.	.	11
	Angler,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	1	1	4
	Cod,	.	.	.	.	2	.	3	1	.	.	.	.	.	.	.	.	.	.	.	.	6
	Haddock,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
	Brassie,	.	3	2	4	13	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	27
	Hake,	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	2	.	3
	Plaice,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
	Lemon sole,	.	7	24	6	2	2	1	.	2	1	.	.	.	.	.	.	.	.	.	.	45
	Common dab,	.	4	16	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	28
	Conger,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	‡1
	Nurse-hound,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
	Thornback skate,	.	.	.	.	2	1	2	3	2	1	1	1	.	1	.	.	.	1	.	.	15
	Cuckoo ray,	.	.	.	1	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	3
																						150
Sept. 6. 7-55 a.m. to 9-55 a.m.	Red gurnard,	.	.	.	.	1	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	3
	Com. gurnard,	.	2	1	3	5	2	3	1	3	1	.	.	.	.	.	.	.	.	.	.	21
	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
	Dragonet,	.	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Cod,	.	.	.	.	.	1	2	1	.	1	.	.	.	.	.	.	.	.	.	.	5
	Haddock,	.	.	.	.	.	1	1	1	.	.	.	1	.	.	.	.	.	.	.	.	4
	Brassie,	1	4	15	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	22
	Poor-cod,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Lemon sole,	1	12	11	3	6	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	35
	Common dab,	.	4	12	6	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	25
	Black sole,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
	Nurse-hound,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
	Thornback skate,	.	.	.	.	.	.	.	1	.	.	1	4	1	.	.	.	.	.	.	1	19
	Cuckoo ray,	.	.	.	.	1	1	3	.	.	.	.	.	2	.	.	.	.	.	.	.	7
																						138
Oct. 5. 12 noon to 1-35 p.m.	Red gurnard,	.	.	.	.	3	2	1	.	1	1	.	.	.	.	.	.	.	.	.	.	8
	Com. gurnard	.	.	.	1	.	1	5	1	2	1	.	.	.	.	.	.	.	.	.	.	11
	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	‖1
	Dragonet	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Cod,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
	Scald-fish	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Lemon sole,	.	6	8	13	2	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	33
	Common dab,	.	.	.	1	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Grey skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	¶1
	Thornback skate,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	**3
	Cuckoo ray,	.	.	1	.	2	.	2	.	.	.	.	3	.	.	.	.	1	.	.	.	††10
																						74

‖ One 28 inches. * 26 inches. § 30 inches. † One 30 inches. ¶ 35 inches. ‡ Over 40 inches. ** One 28 inches. †† One 3 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1899.

A. FISH CAUGHT—Firth of Clyde—*continued.*

Station, Date, and Time Trawl Down.	Kind of Fish.	Size in Inches.																			Total.
		-4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
Station VI.																					
Nov. 14. 8-56 a.m. to 9-30 a.m.	Streaked gurnard,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
	Red gurnard,	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	2
	Com. gurnard,	.	1	7	5	5	1	1	1	3	5	.	1	.	.	.	.	.	.	.	30
	Cod,	.	.	.	.	.	.	.	1	1	1	.	.	.	.	.	.	.	.	.	3
	Haddock,	.	.	.	.	.	1	.	1	.	3	3	1	.	.	.	.	.	.	.	9
	Brassie,	.	2	9	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	13
	Whiting,	.	.	.	.	.	1	5	7	8	.	.	.	.	.	.	.	.	.	.	21
	Hake,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1
	Lemon sole,	.	2	1	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7
	Common dab,	.	3	7	5	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	16
	Black sole,	.	.	.	.	1	1	.	1	1	.	1	.	1	.	.	.	.	.	.	6
	Nurse-hound,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	1	3
	Thornback skate,	.	.	.	.	.	1	.	1	1	2	.	3	.	2	.	.	.	.	.	*11
	Cuckoo ray,	1	1	2	.	1	.	.	.	.	.	.	2	2	.	.	.	.	.	.	9
																					132
Dec. 6. 1-19 p.m. to 1-0 p.m.	Red gurnard,	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1
	Com. gurnard,	.	3	14	34	26	7	1	2	.	4	.	.	.	.	.	.	.	.	.	91
	Pogge,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Cod,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
	Haddock,	.	.	.	.	.	2	5	.	.	.	.	.	.	.	.	.	.	.	.	7
	Brassie,	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	†3
	Whiting,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
	Lemon sole,	.	.	.	4	.	1	.	2	1	.	.	.	.	.	.	.	.	.	.	8
	Common dab,	.	1	22	25	9	3	.	.	1	.	.	.	.	.	.	.	.	.	.	61
	Black sole,	.	.	.	.	.	.	2	1	.	1	.	3	2	.	.	.	.	.	.	9
	Thornback skate,	.	1	.	.	.	.	1	2	2	1	1	1	1	.	.	.	.	.	.	‡12
	Cuckoo ray,	.	.	.	.	.	1	.	1	.	1	1	4	2	.	.	.	.	.	.	‖11
																					206
Station VII.																					
Jan. 17. 1-46 p.m. to 3-27 p.m.	Com. gurnard,	.	1	1	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
	Haddock,	.	.	.	.	.	.	.	.	.	2	2	.	.	.	.	.	.	.	.	4
	Brassie,	.	.	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Whiting,	.	1	1	.	11	.	.	.	12	.	2	.	.	.	.	.	.	.	.	27
	Hake,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
	Ling,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	§1
	Long rough dab,	1	1	1	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7
	Plaice,	.	.	.	.	.	.	.	.	.	1	1	.	1	.	.	.	.	.	.	3
	Witch sole,	.	.	.	.	.	3	.	18	13	32	11	10	.	.	.	.	.	.	.	87
	Common dab,	.	6	.	3	2	.	1	1	.	.	.	.	.	.	.	.	.	.	.	13
	Black sole,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Argentine,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Thornback skate,	.	.	.	.	2	1	1	1	.	1	.	.	.	.	.	.	.	.	.	6
	Fuller's ray,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
																					161
May 29. 8-20 a.m. to 11-5 a.m.	Red gurnard,	1	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Com. gurnard,	.	.	.	3	5	3	1	1	2	2	.	.	.	.	.	.	.	.	.	17
	John Dory,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
	Dragonet,	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Cod,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Haddock,	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1
	Brassie,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Whiting,	.	.	.	4	9	1	1	1	.	.	.	.	.	.	.	.	.	.	.	16
	Hake,	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	1	3
	Long rough dab,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	¶3
	Lemon sole,	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Witch sole,	.	.	.	.	2	3	6	10	13	17	6	2	2	.	.	.	.	.	.	61
	Common dab,	.	1	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Thornback skate,	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**5
																					120

* One 35 inches. † One 3 inches. ‡ One 28, one 30 inches. ‖ One 3 inches. § 49 inches.
¶ Two 3 inches. ** Three 3 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1899.

A. FISH CAUGHT—Firth of Clyde—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																			Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
Station VII.																					
June 7.	Com. gurnard,	.	.	1	6	10	1	.	2	.	3	.	.	.	.	.	.	.	.	.	.	23
6-15 p.m.	Haddock,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
to	Brassie,	.	.	5	10	3	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*22
7-52 p.m.	Whiting,	.	.	.	1	1	1	3	1	1	.	.	.	.	.	.	.	.	.	.	.	8
	Hake,	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	1	3
	Long rough dab,	.	1	5	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7
	Lemon sole,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Witch sole,	.	.	.	1	1	3	7	14	9	6	1	1	1	.	.	.	.	.	.	.	44
	Common dab,	.	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Conger,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	†1
	Thornback skate,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	‡4
																					117
Night Trawl.																					
June 15.	Com. gurnard,	.	.	3	11	6	5	2	1	3	1	1	.	.	.	.	.	.	.	.	.	33
9-40 p.m.	Dragonet,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
to	Cod,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	‖2
11-40 p.m.	Haddock,	.	.	1	1	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	4
	Brassie,	.	3	1	4	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	14
	Poor-cod,	4	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	§7
	Whiting,	.	.	.	.	.	6	5	7	4	2	1	.	.	.	.	.	.	.	.	.	25
	Hake,	.	.	.	.	.	.	.	.	.	1	1	.	2	.	.	.	.	.	.	.	4
	Ling,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	¶1
	Long rough dab,	1	.	7	2	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	10
	Lemon sole,	.	.	1	2	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	5
	Witch sole,	.	.	.	.	3	9	15	45	28	34	8	8	.	.	.	.	.	.	.	.	150
	Common dab,	.	4	6	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11
	Black sole,	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Grey skate,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
																					270
July 7.	Com. gurnard,	.	.	2	6	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10
4-17 p.m.	Haddock,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
to	Whiting,	.	.	.	2	6	3	.	1	.	.	.	.	.	.	.	.	.	.	.	.	12
6-5 p.m.	Hake,	.	.	.	.	.	.	.	.	.	.	3	1	1	.	.	.	.	.	.	.	5
	Long rough dab,	3	1	7	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**16
	Scald-fish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	††1
	Witch sole,	.	.	.	.	2	4	13	18	14	7	3	.	.	.	.	.	.	.	.	.	61
	Common dab,	.	2	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
	Nurse-hound,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
	Thornback skate,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
																					113
Night Trawl.																					
July 19.	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1
9-35 p.m.	Dragonet,	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
to	Cod,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	‡‡3
11-20 p.m.	Haddock,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Brassie,	3	8	2	1	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	17
	Poor-cod,	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Whiting,	.	.	.	3	7	3	1	.	1	.	1	.	.	.	.	.	.	.	.	.	16
	Hake,	.	.	.	.	.	.	.	.	.	2	.	1	.	.	.	.	.	.	.	.	3
	Lemon sole,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Witch sole,	.	.	.	.	.	4	10	14	10	6	2	.	.	.	.	.	.	.	.	.	46
	Common dab,	.	4	2	3	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	13
	Conger,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	‖‖1
	Thornback skate,	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	§§5
																					112
Sept. 12.	Red gurnard,	.	.	.	.	.	.	.	1	1	2	.	.	.	.	.	.	.	.	.	.	4
10-25 a.m.	Com. gurnard,	.	.	8	7	16	3	3	2	2	.	.	.	.	1	.	.	.	.	.	.	42
to	Angler,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
0-10 p.m.	Brassie,	.	14	8	.	1	1	3	2	1	.	1	.	.	.	.	.	.	.	.	.	31
	Hake,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	2
	Scald-fish	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Lemon sole,	1	5	7	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	15
	Witch sole,	.	.	.	.	.	1	1	2	1	.	.	1	.	.	.	.	.	.	.	.	6
	Common dab,	6	9	13	4	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	35
	Thornback skate,	6	.	1	.	1	.	.	.	3	1	1	1	.	.	.	.	.	.	1	.	15
																					152

* One 3 inches. † Over 40 inches. Three 3 inches. ‖ One 30 inches. § One 3 inches.
¶ 40 inches. ** One 3 inches. †† 3 inches. ‡‡ 35 inches. ‖‖ 40 inches. §§ Two 3 inches.

ABLE C.—Record of Observations made on Board the 'Garland' during 1899.

FISH CAUGHT—Firth of Clyde—*continued.*

ion, , and ne wl wn.	Kind of Fish.	Size in Inches.																				Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
tion II.																						
6.	Com. gurnard,	.	.	2	1	1	1	1	1	1	.	.	.	.	.	.	.	.	.	.	.	8
p.m.	Angler,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
o	Dragonet,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
p.m.	Haddock,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
	Brassie,	.	.	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
	Hake,	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	2
	Scald-fish	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*2
	Lemon sole,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Witch sole,	.	.	.	.	2	1	1	1	2	.	.	.	.	.	.	.	.	.	.	.	7
	Common dab,	3	4	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11
	Thornback skate,	2	5	2	.	.	1	.	.	.	2	.	1	.	1	.	.	.	.	1	.	15
	Cuckoo ray,	.	.	.	.	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	3
																						58
15.	Com. gurnard,	.	.	.	.	7	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	8
p.m.	Angler	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	†1
o	Cod,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	‡1
p.m.	Brassie,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Lemon sole,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Witch sole,	.	.	.	.	.	.	10	2	4	2	.	.	.	.	.	.	.	.	.	.	18
	Common dab,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Black sole,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Conger,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	§1
	Piked dog-fish,	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	‖4
	Thornback skate,	1	6	.	.	.	.	.	.	1	.	2	.	.	.	.	.	.	.	.	.	10
																						47
12.	Streaked gurnard,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
a.m.	Com. gurnard,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
o	Long rough dab,	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
a.m.	Thornback skate,	.	.	.	.	1	.	.	.	.	.	1	1	.	.	.	.	.	.	1	.	¶5
	Cuckoo ray	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
																						12
tion If.																						
29.	Red gurnard,	.	.	.	1	.	.	1	.	2	.	.	1	.	.	.	.	.	.	.	.	5
p.m.	Com. gurnard,	.	.	1	20	20	10	10	.	1	1	.	.	.	.	.	.	.	.	.	.	63
o	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**2
p.m.	Dragonet,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Whiting,	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Hake,	.	.	.	.	.	.	.	.	.	3	6	.	2	.	.	.	.	1	1	2	††17
	Long rough dab,	1	1	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	3
	Brill,	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1
	Sail-fluke	.	.	.	.	.	.	.	1	2	.	1	.	.	.	.	1	1	1	.	.	7
	Lemon sole,	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Witch sole,	.	.	.	2	17	41	46	56	42	23	8	2	2	.	.	.	.	.	.	.	239
	Black sole,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
	Grey skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1
	Thornback skate,	.	.	.	.	.	.	2	.	.	1	.	2	.	.	.	.	.	.	.	1	6
																						350
8.	Red gurnard,	.	.	.	.	.	.	.	.	3	.	1	3	4	.	.	.	.	.	.	.	11
a.m.	Com. gurnard,	.	1	.	4	6	9	1	1	.	1	.	.	.	.	.	.	.	.	.	.	23
o	Whiting,	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	2
p.m.	Hake,	.	.	.	.	.	.	.	1	4	5	2	2	.	.	2	.	1	.	2	2	‡‡28
	Long rough dab,	.	.	3	4	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8
	Sail-fluke,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1
	Scald-fish,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Witch sole,	.	.	1	9	10	33	33	23	16	9	9	2	.	.	.	.	.	.	.	.	145
	Common dab,	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Piked dog-fish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	.	.	3
	Thornback skate,	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	1	.	3
																						227

One 3 inches. † Over 40 inches. ‡ Over 40 inches. § Over 40 inches. ‖ One 28 one 30 inches.
¶ One 28 inches. * 35 inches. †† Two 30 inches. ‡‡ Two 3, two 28, one 30, two 35 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1899.

A. FISH CAUGHT—Firth of Clyde—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																			Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
Station VIII.																					
Night Trawl.																					
June 13.	Red gurnard,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
9-55 p.m.	Com. gurnard,	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	2
to	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	2
11-55 p.m.	Poor-cod,	.	11	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	13
	Whiting,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Hake,	.	.	.	.	.	.	.	.	.	1	.	.	1	1	.	.	.	.	1	4
	Long rough dab,	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Witch sole,	.	.	.	.	9	20	13	8	8	6	3	.	.	.	.	.	.	.	.	67
	Argentine,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
																					94
July 7.	Com. gurnard,	.	.	1	2	12	4	2	.	.	.	.	1	.	.	.	.	.	.	.	22
12 noon	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	*2
to	Whiting,	.	.	.	.	3	3	1	.	.	.	.	.	.	.	.	.	.	.	.	7
2-5 p.m.	Hake,	.	.	.	.	.	.	.	.	.	2	2	.	.	.	.	.	.	1	.	†6
	Three-bearded rockling,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Long rough dab,	.	1	2	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	5
	Sail-fluke,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	2
	Scald-fish,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Witch sole,	.	.	.	3	17	22	26	22	19	2	3	2	1	.	.	.	.	.	.	117
	Grey skate,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	2
																					166
Night Trawl.																					
21 July.	Com. gurnard,	.	.	.	1	.	2	1	.	.	.	1	.	.	.	.	.	.	.	.	5
8-50 p.m.	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	‡1
to	Cod,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	§1
10-50 p.m.	Brassie,	.	.	2	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Poor-cod,	6	29	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	39
	Whiting,	.	2	6	2	4	1	2	.	1	.	.	.	.	.	.	.	.	.	.	18
	Hake,	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	3	2	‖9
	Long rough dab,	3	4	6	5	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	19
	Sail-flukes,	.	2	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	4
	Witch sole,	.	.	2	.	6	22	10	19	9	9	1	5	.	.	.	.	.	.	.	83
	Conger,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	¶1
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1
																					185
Sept. 13.	Com. gurnard,	.	.	1	8	6	3	.	1	1	.	.	.	.	.	.	.	.	.	.	20
0-30 p.m.	Whiting,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
to	Long rough dab,	.	.	.	2	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	4
2-15 p.m.	Sail-fluke,	.	2	3	1	.	.	.	.	.	.	1	2	1	.	.	.	.	.	.	10
	Witch sole,	.	.	1	2	7	36	30	16	7	3	1	2	.	.	.	.	.	.	.	105
	Piked dog-fish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**1
	Grey skate,	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1
	Fuller's ray,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
	Thornback skate,	.	.	.	.	1	.	1	.	.	1	.	.	.	1	.	1	1	.	1	7
	Cuckoo ray,	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1
																					151
Oct. 10.	Com. gurnard,	.	.	2	3	31	29	21	12	7	10	1	1	.	.	.	.	.	.	.	117
8-0 a.m.	Brassie,	1	86	104	7	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	202
to	Whiting,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
9-55 a.m.	Sail-fluke,	.	.	10	3	.	1	1	.	.	1	.	.	.	.	.	.	.	.	.	16
	Lemon sole,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Sprat,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Nurse-hound,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	††1
	Thornback skate,	.	1	.	1	.	1	1	.	.	.	1	1	.	.	.	.	.	.	.	6
	Cuckoo ray,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1
																					346

* One 35 inches. † One 30 inches. ¶ 35 inches. ‡ 30 inches. ** 28 inches. § 35 inches. †† 30 inches. ‖ One 30, one 35 inches.

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' DURING 1899.

A. FISH CAUGHT—FIRTH OF CLYDE—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																			Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
Station VIII.																					
Nov. 23.	Red gurnard,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
4.53 a.m.	Com. gurnard,	.	.	1	.	1	2	1	3	1	5	1	.	.	.	.	.	.	.	.	.	15
to	Angler,	.	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	*3
6.8 a.m.	Whiting,	.	.	.	.	.	4	4	2	.	1	.	.	.	.	.	.	.	.	.	.	11
	Hake,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1
	Brill,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
	Sail-fluke,	.	.	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	3
	Scald-fish,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Witch sole,	.	.	1	5	15	14	7	4	1	.	.	.	.	.	.	.	.	.	.	.	47
	Argentines,	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Piked dog-fish,	.	.	.	.	.	.	.	.	.	.	2	1	.	.	1	1	.	.	.	.	†9
	White skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	2
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	‡3
																					100
Dec. 12.	Com. gurnard,	.	.	1	2	2	4	5	2	4	1	.	.	.	.	.	.	.	.	.	.	21
1 p.m.	Angler,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
to	Brassie,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
1 p.m.	Poor-cod,	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Whiting,	.	.	.	.	.	3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	5
	Hake,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	3	.	.	5
	Sail-fluke,	.	.	1	4	.	.	1	.	.	1	.	.	.	1	.	.	.	.	.	.	8
	Scald-fish,	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Witch sole,	.	.	.	.	2	4	2	3	4	.	2	1	.	.	.	.	.	.	.	.	18
	Argentine,	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Nurse-hound,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1
	Piked dog-fish,	.	.	.	.	.	.	1	.	.	.	1	.	.	2	.	.	1	.	2	2	§12
Station																					79
Dec. 17.	Red gurnard,	.	.	.	.	.	.	.	2	.	3	.	1	1	.	.	.	.	.	.	.	7
11 a.m.	Com. gurnard,	.	.	.	.	1	4	2	4	16	4	.	.	.	.	.	.	.	.	.	.	31
	Angler,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1	.	2
3 a.m.	Brassie,	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Whiting,	.	.	.	31	.	14	2	3	.	.	.	.	.	.	.	.	.	.	.	.	50
	Poor-cod,	3	13	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	16
	Hake,	.	.	.	.	.	.	.	.	6	5	3	.	.	.	1	.	.	.	.	.	‖16
	Long rough dab,	.	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Plaice,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
	Witch sole,	.	.	.	.	1	6	.	10	2	13	5	.	.	.	.	.	.	.	.	.	37
	Common dab,	5	4	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	13
	Black sole,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
	Zeugopterus, sp.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Argentine,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	¶4
	Conger,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**1
	Thornback skate,	.	.	.	.	.	.	.	1	1	1	1	.	1	1	.	.	.	.	.	.	6
																					191
Dec. 29.	Com. gurnard,	.	.	1	5	9	1	3	1	3	.	.	.	.	.	.	.	.	.	.	.	23
1 a.m.	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	††2
	Cod,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
1.10 a.m.	Hake,	.	.	.	.	.	.	.	.	1	4	5	3	3	2	1	2	4	3	3	.	‡‡33
	Ling,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	§§1
	Long rough dab,	1	3	4	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9
	Sail-fluke,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1
	Witch sole,	.	.	.	3	6	15	18	23	13	5	5	.	.	.	.	.	.	.	.	.	§8
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	2
																					160
Dec. 8.	Com. gurnard,	.	1	1	7	4	1	6	.	.	.	.	.	.	.	.	.	.	.	.	.	20
9 a.m.	Whiting,	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Hake,	.	.	.	.	.	.	.	.	1	2	3	.	2	1	1	.	.	.	.	1	11
1 a.m.	Long rough dab,	1	.	4	7	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	14
	Lemon sole,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Witch sole,	.	.	3	6	16	27	27	24	21	12	6	1	.	.	.	.	.	.	.	.	143
	Piked dog-fish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	4	.	6
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	‖‖3
																					200

* 25 inches. † Three 26, one 28 inches. ‡ One 3 inches. § Two 28, one 30 inches. ‖ One over 40 inches.
** 3 inches. ** 48 inches. †† One 28 inches. ‡‡ One 26, one 28 inches. §§ Over 40 inches. ‖‖ Two 3 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1899.

A. FISH CAUGHT—Firth of Clyde—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																			Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
Station IX.																					
July 8.	Com. gurnard,	.	.	.	5	11	5	4	2	1	3	1	1	.	.	.	.	.	.	.	33
10-30 a.m.	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*2
to	Whiting,	.	.	.	.	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	4
11-45 a.m.	Hake,	.	.	.	.	.	.	.	.	.	1	.	.	.	2	.	.	.	1	3	4 †18
	Long rough dab,	1	1	16	7	6	2	.	.	.	.	.	.	.	.	.	.	.	.	.	33
	Sail-fluke,	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	2
	Witch sole,	.	.	1	4	15	24	31	22	24	8	6	3	1	1	.	.	.	.	.	140
	Common dab,	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Nurse-hound,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
	Piked dog-fish,	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	1	3
	Thornback skate,	.	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	1	2	‡6
																					244
Sept. 8.	Com. gurnard,	.	.	.		2	2	3	5	.	.	.	.	.	.	.	.	.	.	1	13
9-39 a.m.	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	§2
to	Whiting,	.	.	.	.	31	29	6	1	.	.	.	.	.	.	.	.	.	.	.	‖68
11-35 a.m.	Hake,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1
	Long rough dab,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Sail-fluke,	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	2
	Witch sole,	.	.	.	.	2	4	1	4	2	1	.	.	.	.	.	.	.	.	.	14
	Nurse-hound,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	¶1
	Piked dog-fish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	2
																					105
Oct. 10.	Com. gurnard,	.	.	.	.	.	1	.	.	2	.	1	.	.	.	.	.	.	.	.	4
11-39 a.m.	Whiting,	.	.	.	.	2	4	5	1	1	.	.	.	.	.	.	.	.	.	.	13
to	Hake,	.	.	.	.	1	.	.	.	.	.	.	.	1	.	1	.	.	.	.	3
1-43 p.m.	Sail-fluke,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Witch sole,	.	.	.	.	8	8	5	4	2	1	.	.	.	.	.	.	.	.	.	28
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	**3
																					52
Nov. 15.	Com. gurnard,	.	.	.	4	6	3	2	5	4	2	.	.	.	.	.	.	.	.	.	26
10-0 a.m.	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	††2
to	Brassie,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
11-47 a.m.	Poor-cod	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Whiting,	.	.	.	.	.	.	2	.	1	.	.	.	.	.	.	.	.	.	.	3
	Hake,	.	.	.	.	.	.	2	.	1	1	.	.	.	.	.	.	.	1	.	4
	Sail-fluke,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1
	Witch sole,	.	.	1	2	5	14	8	4	5	2	1	1	.	.	.	.	.	.	.	43
	Conger,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	‡‡1
	Piked dog-fish,	.	.	.	.	.	.	.	.	.	.	1	3	15	12	9	1	.	1	.	§§45
	Thornback skate,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	3
																					131
Dec. 13.	Red gurnard,	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	2
9-0 a.m.	Com. gurnard	.	.	.	1	15	14	4	2	.	3	.	.	.	.	.	.	.	.	.	39
to	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	‖‖1
10-53 a.m.	Poor-cod,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Whiting,	.	.	.	.	.	.	4	1	.	.	.	.	.	.	.	.	.	.	.	5
	Sail-fluke,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Witch sole,	.	.	.	.	1	3	10	8	9	5	2	.	.	.	.	.	.	.	.	38
	Conger,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	¶¶1
																					88

* One 30, one 35 inches. † Three 30, three 35, one 40 inches. ‡ One 28 inches. § One 30 inches. ‖ One 3 inches.
¶ 26 inches. ** One 40 inches. †† One 30 inches. ‡‡ Over 40 inches. §§ Three 28 inches. ‖‖ 30 inches. ¶¶ Over 40 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1899.

A. FISH CAUGHT—Firth of Clyde—*continued.*

ation. ge, and time rawl own.	Kind of Fish.	Size in Inches. 4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19" +	20 +	21 +	23 +	25 +	Total.
tion X.																						
n. 16.	Haddock,	2	1	.	2	.	.	.	3	3	.	5	1	.	.	.	.	.	.	.	.	*18
0 a.m.	Brassie,	1	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	4
to	Poor-cod,	6	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10
0 p.m.	Whiting,	.	4	.	6	63	.	.	43	.	12	.	2	.	.	.	.	.	.	.	.	130
	Hake,	.	.	.	.	.	.	.	4	48	33	12	.	.	4	2	2	.	.	.	3	108
	Long rough dab,	4	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7
	Lemon sole,	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	2
	Witch sole,	.	.	.	.	.	6	13	.	13	13	17	.	2	.	.	.	.	.	.	.	64
	Common dab,	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Black sole,	.	.	.	.	.	.	.	.	1	1	.	1	.	1	.	.	.	.	.	.	4
	Argentine,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	†2
	Thornback skate,	.	.	1	.	.	.	.	.	.	1	.	1	.	.	.	1	.	.	.	.	4
	Fuller's ray,	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	1	.	3
																						358
ay 30.	Com. gurnard,	.	.	2	7	4	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	15
a.m.	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1
to	Dragonet,	1	1	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	‡6
5 a.m.	Whiting,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Hake,	.	.	.	.	.	.	.	1	.	2	1	1	2	.	.	.	2	.	.	.	9
	Long rough dab,	.	9	29	27	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	67
	Turbot,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
	Scald-fish,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Lemon sole,	.	.	4	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
	Witch sole,	.	.	.	.	.	5	6	10	4	4	.	1	.	.	1	.	.	.	.	.	31
	Common dab,	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Black sole,	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	2
	Grey skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	§1
	Thornback skate,	.	.	.	.	.	1	3	.	.	.	.	.	1	.	1	.	.	.	.	.	6
	Cuckoo ray,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1
																						149
: 13.	Red gurnard,	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	2
p.m.	Com. gurnard,	.	.	2	27	8	1	3	4	.	.	.	.	.	.	.	.	.	.	.	.	45
	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1
p.m.	Dragonet,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Haddock,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Whiting,	.	.	.	.	1	1	.	2	.	.	.	.	.	.	.	.	.	.	.	.	4
	Hake,	.	.	.	.	.	.	.	.	1	.	2	.	1	.	.	.	.	.	2	1	‖11
	Long rough dab,	2	9	21	27	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	61
	Zeugopterus, sp.?	1	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Lemon sole,	.	1	2	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
	Witch sole,	.	.	.	.	1	.	2	10	10	5	1	4	.	.	.	.	.	.	.	.	33
	Common dab,	.	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Black sole,	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	2
	Piked dog-fish,	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1
	Thornback skate,	.	.	.	.	.	.	.	1	1	2	2	1	1	1	.	1	.	.	.	.	10
	Cuckoo ray,	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	¶4
																						188
19.	Com. gurnard,	.	.	2	5	5	5	8	4	5	1	.	.	.	.	.	.	.	.	.	.	35
a.m.	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Dragonet,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
p.m.	Whiting,	.	.	.	3	7	6	1	.	.	.	.	.	.	.	.	.	.	.	.	.	17
	Hake,	.	.	.	.	.	.	.	.	.	1	.	4	2	.	.	1	1	3	2	.	14
	Long rough dab,	2	10	18	10	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	††42
	Sail-fluke,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Scald-fish,	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Lemon sole,	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Witch sole,	.	.	.	6	6	7	5	20	14	9	3	.	1	.	.	.	.	.	.	.	71
	Blac e sole,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
	Piked dog-fish,	.	.	.	.	.	.	.	.	1	.	1	2	3	3	.	1	.	1	.	.	12
	Thornback skate,	1	.	1	.	.	.	1	1	.	.	1	2	.	1	.	.	1	.	.	.	9
																						209

One 3 inches. † One 3 inches. ‡ One 2, one 3 inches. § 35 inches. ‖ Two 28, two 30 inches. ¶ One 3 inches.
** 35 inches. †† Two 3 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1899.

A. FISH CAUGHT—Firth of Clyde—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																		Tot.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
Station X.																						
Sept. 6.	Com. gurnards,	.	4	20	90	17	4	3	1	1	.	.	.	.	.	.	.	.	.	.	.	1
4-7 p.m.	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	
to	Dragonet,	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
5-5 p.m.	Haddock,	.	.	.	.	9	14	2	1	.	.	.	.	.	.	.	.	.	.	.	.	
	Brassie,	1	39	38	11	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Poor cod,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Whiting,	.	.	.	.	10	25	14	1	1	.	.	.	.	.	.	.	.	.	.	.	
	Hake,	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	
	Long rough dab,	.	1	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Lemon sole,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Argentine,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	White-hound,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Nurse-hound,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	
	Thornback skate,	.	.	.	.	2	1	1	5	.	4	4	1	.	.	.	.	.	.	1	.	
	Cuckoo ray,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	
																						3
Oct. 9.	Com. gurnard,	.	1	3	8	9	4	2	.	2	.	.	.	.	.	.	.	.	.	.	.	
11-5 a.m.	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
to	Hake,	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	1	
1-5 p.m.	Common dab,	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Thornback skate,	.	2	.	.	.	.	1	.	.	.	1	.	.	1	.	.	.	.	1	.	
Nov. 14.	Red gurnard,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	
11-38 a.m.	Com. gurnard,	.	.	2	3	10	6	3	2	2	.	.	.	1	.	.	.	.	.	.	.	
to	Cod,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
1-37 p.m.	Brassie,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Whiting,	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	
	Hake,	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	2	.	.	2	.	
	Sail-fluke,	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Scald-fish,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Witch sole,	.	.	.	.	.	1	5	6	5	3	1	.	.	.	.	.	.	.	.	.	
	Piked dog-fish,	.	.	.	.	.	.	.	.	.	.	5	3	3	1	1	.	.	2	.	.	
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	1	
Dec. 6.	Com. gurnard,	.	.	.	8	13	13	7	5	6	6	1	.	1	.	1	.	.	.	.	.	
8-55 a.m.	Angler,	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	
to	Horse mackerel,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
11-0 a.m.	Poor cod,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Whiting,	.	.	.	.	.	1	1	1	1	.	.	.	.	.	.	.	.	.	.	.	
	Hake,	1	.	.	.	.	.	.	.	3	2	.	1	2	3	3	2	1	.	1	.	
	Long rough dab,	.	1	3	4	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Scald-fish,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Witch sole,	.	.	.	.	4	14	10	14	15	11	5	3	.	.	.	.	.	.	.	.	
	Common dab,	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Nurse-hound,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Piked dog-fish,	.	.	.	.	.	.	2	.	.	.	.	.	.	11	.	9	.	3	.	.	
	Thornback skate,	.	.	.	2	.	.	.	1	.	.	.	1	.	.	.	.	.	1	1	.	
Station XI.																						2
Jan. 24.	Com. gurnard,	.	.	1	.	14	13	1	.	1	.	.	.	.	.	.	.	.	.	.	.	
8-33 a.m.	Streaked ,,	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	
to	Dragonet,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
10-55 a.m.	Haddock,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Whiting,	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Hake,	.	.	.	.	.	.	.	.	7	.	.	.	.	.	.	.	.	.	.	.	
	Brill,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	
	Long rough dab,	8	32	.	22	17	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	‡‡
	Plaice,	.	.	1	1	.	2	.	1	5	3	1	2	2	.	3	1	.	.	.	.	
	Lemon sole,	.	.	1	2	1	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	
	Witch sole,	.	.	.	.	2	5	17	14	1	18	10	2	.	.	.	.	.	.	.	.	
	Common dab,	19	18	13	8	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Black sole,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	§§
																						2

* One 30 inches. † One 3 inches. ‡ 35 inches. § One 3 inches. ‖ 35 inches. ¶ 30 inches.
** One 30 inches. †† 2 inches. ‡‡ One 3 inches. §§ 26 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1899.

A. FISH CAUGHT—Firth of Clyde—*continued.*

ation, te and Time Trawl down.	Kind of Fish.	Size in Inches. 4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	Total.
tion XI.																						
ne 1.	Com. gurnard,	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	2
5 a.m.	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	*2
to	Cod,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
5 a.m.	Haddock,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Brassie,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Whiting,	.	.	.	2	2	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	5
	Hake,	.	.	.	.	.	.	.	2	1	3	1	1	.	1	1	.	.	.	1	.	11
	Long rough dab,	6	13	59	25	9	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	112
	Lemon sole,	.	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	2
	Witch sole,	.	.	.	.	.	2	2	3	4	7	5	5	1	.	.	.	.	.	.	.	29
	Common dab,	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Grey skate,	.	.	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	2
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2	.	.	4
																						174
ly 4.	Com. gurnard,	.	.	.	3	8	1	1	1	1	1	1	1	1	.	.	.	.	.	.	.	19
5 a.m.	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	†1
to	Whiting,	.	.	.	.	6	6	3	.	1	.	.	.	.	.	.	.	.	.	.	.	16
5 a.m.	Hake,	.	.	.	.	.	.	.	.	.	5	3	2	.	.	.	.	.	.	1	.	11
	Three-bearded rockling,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Long rough dab,	4	10	71	27	5	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	119
	Witch sole,	.	.	.	.	.	4	5	1	9	6	5	6	1	.	.	.	.	.	.	.	37
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	2
																						206
pt. 15.	Com. gurnard,	.	.	1	6	17	19	8	5	7	.	1	.	.	.	.	.	.	.	.	.	64
5 a.m.	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11
to	Whiting,	.	.	.	.	4	19	4	.	.	.	.	.	.	.	.	.	.	.	.	.	27
5 a.m.	Hake,	.	.	.	.	1	6	2	1	.	1	1	.	1	4	.	1	.	1	.	.	19
	Long rough dab,	3	5	39	21	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	76
	Plaice,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	2	.	.	.	.	4
	Witch sole,	.	.	.	2	2	4	8	15	20	19	10	2	.	.	.	.	.	.	.	.	82
	Common dab,	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Piked dog-fish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
	Fuller's ray,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
																						278
ct. 12.	Com. gurnard,	.	.	.	.	1	2	.	2	3	.	.	.	.	.	.	.	.	.	.	.	8
5 a.m.	Brassie,	.	4	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
to	Poor-cod,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	§1
1-30 a.m.	Whiting,	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Hake,	.	.	.	.	.	3	1	1	.	.	.	1	2	.	1	.	.	1	.	.	‖11
	Three-bearded rockling,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Long rough dab,	1	3	18	7	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	¶32
	Plaice,	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	2
	Witch sole,	.	.	.	2	3	7	10	8	9	2	2	2	.	.	.	.	.	.	.	.	45
	Common dab,	2	2	2	3	4	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	14
	Piked dog-fish,	.	.	.	.	.	.	.	.	.	.	3	.	1	2	.	.	.	.	.	.	6
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	1	.	3
																						130
Nov 29.	Com. gurnard,	.	.	.	2	11	7	28	17	13	18	6	.	.	.	.	.	.	.	.	.	102
1-55 p.m.	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1
to	Brassie,	.	1	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
4-27 p.m.	Poor-cod,	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Whiting,	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	2
	Hake,	.	.	.	.	.	.	.	7	.	.	.	.	.	3	1	2	3	.	1	.	**21
	Long rough dab,	5	10	31	23	4	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	75
	Plaice,	.	.	.	.	.	.	.	.	.	1	.	.	.	1	1	.	2	1	.	.	6
	Lemon sole,	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Witch sole,	.	.	.	3	5	13	28	10	9	3	4	3	.	.	.	.	.	.	.	.	78
	Common dab,	1	6	2	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11
	Argentine,	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Piked dog-fish,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
	Fuller's ray,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	2
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	3
																						312

* One 30 inches. † 30 inches. ‡ Over 40 inches. § 3 inches. ‖ One 30 inches.
¶ Two 3 inches. ** Four 3 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1899.

A. FISH CAUGHT—Firth of Clyde—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																		Tot
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
Station XI.																						
Dec. 15.	Com. gurnard,	.	.	2	3	3	1	5	3	2	1	1	.	.	.	.	.	.	.	.	.	
1-28 p.m.	Angler,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	
to	Brassie,	.	1	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
3-0 p.m.	Poor-cod,	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Whiting,	.	.	.	.	.	.	2	.	1	.	.	.	.	.	.	.	.	.	.	.	
	Hake,	5	.	.	.	.	.	.	1	1	.	.	.	1	1	2	1	.	2	3	1	
	Long rough dab,	.	.	1	7	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Plaice,	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	
	Witch sole,	.	.	.	.	7	10	13	16	10	4	5	2	2	.	.	.	.	.	.	.	
	Common dab,	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Piked dog-fish,	.	.	.	.	.	.	.	.	4	2	2	5	5	1	2	.	.	.	.	.	
	Thornback skate,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	
Station XII.																						
Jan. 20.	Red gurnard,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	
10-24 a.m	Com. gurnard,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
to	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
0-10 p.m.	Cod,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Brassie,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Poor-cod,	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Whiting,	.	.	.	1	7	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Hake,	.	.	1	.	3	.	.	.	.	15	.	.	.	3	.	2	3	.	.	2	¶
	Rockling sp.,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Long rough dab,	.	37	67	97	144	56	4	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Plaice,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Witch sole,	13	.	.	4	.	8	.	16	20	.	19	.	28	.	.	.	.	.	.	.	
	Black sole,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	
	Argentine,	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Thornback skate,	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	
	Fuller's ray,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	
May 31.	Com. gurnard,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
8-43 a.m.	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	
to	Cod,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
10-43 a.m.	Brassie,	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Whiting,	.	7	1	.	2	5	2	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Hake,	.	.	1	1	.	.	.	.	.	1	2	.	1	.	.	.	.	1	2	.	§§
	Long rough dab,	19	38	94	33	7	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Witch sole,	.	.	.	.	3	1	1	3	2	8	9	8	3	.	.	.	.	.	.	.	
	Argentine,	.	.	.	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	
June 17.	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
to	Whiting,	1	4	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
9-35 a.m.	Hake,	.	.	.	1	.	.	.	.	.	1	2	4	1	.	.	2	.	1	.	.	¶¶
	Long rough dab,	5	19	131	112	30	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Witch sole,	.	1	2	.	3	1	4	10	10	5	9	5	3	.	.	.	.	.	.	.	
	Conger,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Thornback skate,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	1	.	.	1	.	
Night Trawl.																						
June 12.	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	
10-5 p.m.	Cod,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
to	Brassie,	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
0-45 a.m.	Poor-cod,	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Whiting,	.	.	.	3	2	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	
	Hake,	.	.	1	.	2	.	.	.	.	1	2	.	.	.	.	.	.	.	1	1	‡‡‡
	Long rough dab,	.	6	79	61	11	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Witch sole,	2	.	1	.	3	4	3	5	10	6	13	4	1	.	.	.	.	.	.	.	
	Conger,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	
	Thornback skate,	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	

* Two 3 inches. † Two 28 inches. ‡ 35 inches. § 38 inches. ‖ Five 3 inches. ¶ Three 26, one 28 inches
** One between 2 and 3 inches, one 26 inches. †† One 28, two 30 inches. ‡‡ 35 inches. §§ One 26, one 28 inche
‖‖ 30 inches. ¶¶ One 28 inches. *** 35 inches. ††† 35 inches. ‡‡‡ One 28, two 35 inches.

ABLE C.—Record of Observations made on Board the 'Garland' during 1899.

A. FISH CAUGHT—Firth of Clyde—*continued.*

ion, and ne wl rn.	Kind of Fish.	Size in Inches. 4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	Total.
tion I.																						
24.	Com. gurnard,	.	.	.	.	3	4	3	2	.	.	.	.	.	.	.	.	.	.	.	.	12
a.m.	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*2
	Haddock,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1
a.m.	Poor-cod,	2	1	11	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	14
	Whiting,	.	.	4	7	21	14	4	.	1	.	.	.	.	.	.	.	.	.	.	.	51
	Hake,	.	.	.	1	3	.	.	.	.	.	.	1	1	.	1	.	1	.	.	2	†13
	Long rough dab,	15	10	110	69	12	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	‡218
	Plaice,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1
	Witch sole,	.	.	.	.	1	2	4	5	8	7	14	6	3	.	.	.	.	.	.	.	50
	Argentine,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Piked dog-fish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	2
	Grey skate,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Thornback skate	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	2
																						368
ht wl.																						
18.	Cod,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
p.m.	Poor-cod,	3	11	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	22
	Whiting,	.	.	2	.	3	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10
p.m.	Hake,	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	1	.	.	§4
	Long rough dab,	3	9	64	42	6	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	‖129
	Witch sole,	.	.	1	.	.	2	4	5	7	8	14	10	2	1	.	.	.	.	.	.	54
	Conger,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	¶1
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	1	3
																						224
14.	Com. gurnard,	.	.	.	4	16	10	10	14	9	9	3	3	.	.	.	.	.	.	.	.	78
a.m.	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
to	Norway pout,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
a.m.	Whiting,	.	.	.	.	9	4	3	1	.	.	.	.	.	.	.	.	.	.	.	.	17
	Hake,	.	.	.	.	.	.	.	.	.	.	.	8	4	1	3	1	.	3	2	1	**24
	Long rough dab,	17	28	70	37	16	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	††173
	Plaice,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	1	.	3
	Lemon sole,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Witch sole,	.	.	.	.	3	12	29	30	41	19	17	4	2	.	.	.	.	.	.	.	157
	Argentine,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Piked dog-fish,	.	.	.	.	.	.	.	.	.	1	3	6	13	4	3	.	.	.	.	.	30
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	1	.	3
																						489
ct. 12.	Com. gurnard,	.	.	.	.	1	3	2	4	2	1	2	3	.	.	.	.	.	.	.	.	18
12 a.m.	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
to	Norway pout,	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
12 p.m.	Whiting,	.	.	.	1	2	4	1	.	.	.	.	.	.	.	.	.	.	.	.	.	8
	Hake,	.	.	.	.	.	.	.	1	.	.	.	.	1	1	.	.	.	.	4	1	8
	Long rough dab,	18	19	46	28	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	‡‡126
	Plaice,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
	Witch sole,	.	2	5	9	31	45	50	43	27	10	.	1	.	.	.	.	.	.	.	.	223
	Conger,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	§§1
	Piked dog-fish,	.	.	.	.	.	.	.	.	4	4	6	9	14	7	1	1	.	1	2	.	49
																						437
ov. 28.	Com. gurnard,	.	.	.	.	.	5	3	.	.	1	1	.	.	.	.	.	.	.	.	.	10
8 a.m.	Brassie,	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
to	Poor cod,	.	5	9	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	15
8 a.m.	Norway pout,	5	4	8	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	18
	Whiting,	.	1	.	.	9	9	6	2	.	.	.	.	.	.	.	.	.	.	.	.	27
	Hake,	10	.	.	.	.	.	.	6	.	.	.	.	2	.	6	1	2	2	.	.	‖57
	Long rough dab,	10	5	34	17	2	4	.	.	.	.	.	.	1	.	.	.	.	.	.	.	¶¶76
	Plaice,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Witch sole,	.	1	7	10	25	39	33	31	17	11	5	.	.	.	.	.	.	.	.	.	179
	Common dab,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Argentine,	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	***4
	Conger,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	†††1
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	2
																						393

inches. † One 28, one 30, one 35 inches. ‡ One 3 inches § One 28 inches. ‖ Two 3 inches.
¶ Over 40 inches. ** One 28 inches. †† Two 3 inches. ‡‡ One 2, ten 3 inches. §§ Over 40 inches.
‖‖ Five 2, twenty-three 3 inches. ¶¶ Four 3 inches. *** One 3 inches. ††† Over 40 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1899.

A. FISH CAUGHT—Firth of Clyde—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																			Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
Station XII.																					
Dec. 18.	Com. gurnard,	.	.	.	.	6	16	14	13	15	3	2	.	.	.	.	.	.	.	.	69
10-50 a.m.	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*1
to	Brassie,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
0-45 p.m.	Poor-cod,	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Whiting,	.	.	.	.	.	11	9	3	2	.	.	.	.	.	.	.	.	.	.	25
	Hake,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	2	3	.	2	1	10
	Long rough dab,	.	.	22	34	4	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	61
	Witch sole,	.	.	.	6	16	21	14	10	11	10	4	.	1	.	.	.	.	.	.	93
	Piked dog-fish,	.	.	.	.	.	.	.	.	.	.	.	1	10	.	4	.	.	.	.	†16
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	2
																					282
Station XIII.																					
May 26.	Com. gurnard,	.	1	.	.	2	3	2	1	.	1	.	.	.	.	.	.	.	.	.	10
9-45 a.m.	Cod,	.	.	4	5	2	.	.	.	.	.	.	.	.	.	.	.	1	1	.	13
to	Haddock,	.	.	.	9	3	1	.	.	.	.	.	1	1	.	.	.	.	.	.	15
10-50 a.m.	Brassie,	1	9	.	3	1	3	.	.	.	.	.	.	.	.	.	.	.	.	.	17
	Hake,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1
	Long rough dab,	26	3	18	13	12	2	.	.	.	.	.	.	.	.	.	.	.	.	.	74
	Plaice,	.	.	.	.	.	1	1	.	2	.	4	1	.	.	.	.	.	.	.	9
	Lemon sole,	.	.	.	.	.	.	.	.	1	1	.	.	1	.	.	.	.	.	.	3
	Witch sole,	.	.	.	.	.	.	.	1	6	3	3	1	.	.	.	.	.	.	.	14
	Common dab,	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1
																					160
June 20.	Com. gurnard,	.	.	1	1	.	1	.	.	1	.	.	.	.	1	.	.	.	.	.	4
0-40 p.m.	Cod,	.	.	2	3	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9
to	Haddock,	.	.	.	.	6	1	.	.	.	.	.	.	.	.	.	.	.	.	.	7
1-45 p.m.	Brassie,	1	8	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11
	Whiting,	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	1
	Hake,	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1
	Long rough dab,	4	2	2	10	11	1	.	.	.	.	.	.	.	.	.	.	.	.	.	30
	Plaice,	.	.	.	.	.	.	1	.	1	1	1	2	.	.	1	.	.	.	.	7
	Lemon sole,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
	Witch sole,	.	.	.	.	.	.	.	2	5	3	2	.	.	.	.	.	.	.	.	12
	Common dab,	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Black sole,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
	Thornback skate,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
																					89
July 27.	Com. gurnard,	.	.	.	.	1	2	2	2	3	.	.	.	.	.	.	.	.	.	.	10
2-5 p.m.	Cod,	.	.	.	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
to	Haddock,	.	.	.	.	6	4	.	.	.	.	.	.	.	.	.	.	.	.	.	10
3-10 p.m.	Brassie,	.	2	2	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Whiting,	.	.	.	.	.	2	.	1	.	.	.	.	.	.	.	.	.	.	.	3
	Long rough dab,	5	24	4	3	10	2	.	.	.	.	.	.	.	.	.	.	.	.	.	48
	Plaice,	.	.	.	.	.	.	.	.	.	2	4	1	.	.	.	.	.	.	.	7
	Witch sole,	.	.	.	.	.	.	.	.	.	4	.	.	.	.	.	.	.	.	.	4
	Common dab,	.	.	2	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
																					96
Sept. 27.	Com. gurnard,	.	3	10	21	2	1	1	.	.	1	.	.	.	.	.	.	.	.	.	39
0-30 p.m.	Cod,	.	.	1	.	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	4
to	Brassie,	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
1-37 p.m.	Long rough dab,	3	34	3	2	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	46
	Lemon sole,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
	Witch sole,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
	Common dab,	.	1	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	2
																					101

* 35 inches. † One 30 inches.

ABLE C.—Record of Observations made on Board the 'Garland' during 1899.

A. FISH CAUGHT.—Firth of Clyde—*continued.*

tion, , and me wl wn.	Kind of Fish.	Size in Inches. 4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	Total.
tion III.																						
. 18.	Com. gurnard,	.	2	3	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8
a.m.	Diminutive sucker	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*2
o	Cod,	.	.	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
a.m.	Haddock,	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Brassie,	.	4	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
	Whiting,	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Long rough dab,	2	14	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	19
	Common dab,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Piked dog-fish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
	Fuller's ray,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
																						44
'. 27.	Com. gurnard,	.	.	.	2	1	.	3	.	1	.	.	.	.	.	.	.	.	.	.	.	7
a.m.	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	†1
to	Diminutive sucker	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	‡6
5 a.m.	Cod,	.	.	.	.	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Haddock,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Brassie,	.	2	13	6	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	22
	Long rough dab,	4	5	.	2	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	15
	Witch sole,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
	Piked dog-fish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	3	5	5	.	§18
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	‖1
	Cuckoo ray,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	¶1
																						76
'. 20.	Goby,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**2
a.m.	Diminutive sucker	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	††9
to	Cod,	.	.	.	.	.	.	2	2	.	.	.	.	.	.	.	.	.	.	.	.	4
a.m.	Haddock,	.	.	.	.	.	2	.	1	.	.	.	.	.	1	.	.	.	.	.	.	4
	Brassie,	.	.	4	3	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9
	Long rough dab,	.	.	7	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11
	Lemon sole,	.	.	.	.	.	.	.	2	.	.	.	1	.	.	.	.	.	.	.	.	3
	Witch sole,	.	.	.	.	.	.	.	.	4	1	.	.	.	.	.	.	.	.	.	.	5
	Piked dog-fish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1
	Thornback skate,	.	.	.	.	.	.	.	.	2	.	.	.	1	.	.	.	.	1	.	.	4
																						52
ıtion IV.																						
y 26.	Com. gurnard,	.	.	.	.	.	1	2	1	.	.	.	.	.	.	.	.	.	.	.	.	4
0 a.m.	Cod,	.	.	1	.	.	.	.	.	1	.	.	.	1	1	.	.	.	1	.	.	5
to	Haddock,	.	.	.	1	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	3
p.m.	Brassie,	.	1	.	2	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	‡‡9
	Whiting,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
	Long rough dab,	.	4	7	9	8	9	.	.	.	.	.	.	.	.	.	.	.	.	.	.	37
	Plaice,	.	.	.	.	.	.	.	.	.	.	3	2	.	.	.	.	.	.	.	.	5
	Lemon sole,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
	Witch sole,	.	.	.	.	.	.	.	3	6	6	5	3	.	.	.	.	.	.	.	.	23
	Common dab,	.	.	.	2	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
																						93
e 20.	Com. gurnard,	.	.	1	2	3	1	3	.	1	.	.	.	.	.	.	.	.	.	.	.	11
0 a.m.	Cod,	.	.	3	1	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	1	7
to	Haddock,	.	.	.	2	4	2	.	.	.	.	2	.	.	3	.	.	.	.	.	.	13
p.m.	Brassie,	.	1	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Whiting,	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	2
	Hake,	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	2
	Long rough dab,	2	.	3	4	5	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	15
	Plaice,	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	2
	Lemon sole,	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	2
	Witch sole,	.	.	.	.	.	.	.	1	2	4	3	1	1	.	.	.	.	.	.	.	12
	Common dab,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Piked dog-fish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	3
																						74

* Two 1 inch † 28 inches. ‡ Two 1, four 2 inches. § One 26 inches. ‖ 30 inches ¶ 3 inches.
** 2 inches. †† Six 2, three 3 inches. ‡‡ One 3 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1899.

A. FISH CAUGHT—Firth of Clyde—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																			To
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
Station XIV.																					
July 27.	Com. gurnard,	.	.	2	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
0-5 p.m.	Cod,	.	.	.	4	3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
to	Haddock,	.	.	.	.	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
1-55 p.m.	Brassie,	.	5	5	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Long rough dab,	9	16	5	17	24	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Plaice,	.	.	.	.	.	.	.	.	.	.	2	1	.	.	.	.	.	.	.	.	
	Witch sole,	.	.	.	.	.	.	1	2	3	13	4	2	.	.	.	.	.	.	.	.	
	Common dab,	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Conger,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
Sept. 27.	Com. gurnard,	.	.	.	1	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	
2-18 p.m.	Cod,	.	.	.	.	3	1	3	2	.	.	.	.	.	1	.	.	.	.	.	.	
to	Haddock,	.	.	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	
3-45 p.m.	Brassie,	.	.	11	5	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Norway pout,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Long rough dab,	1	2	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Lemon sole,	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	
	Witch sole,	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	
	Common dab,	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Thornback skate,	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Cuckoo ray,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	
Oct. 18.	Com. gurnard,	.	.	2	1	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	
10-0 a.m.	Haddock,	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
to	Brassie,	.	2	14	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
11-15 a.m.	Norway pout,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Whiting,	.	.	.	.	.	.	4	.	1	.	.	.	.	.	.	.	.	.	.	.	
	Hake,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	
	Long rough dab,	3	18	4	7	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
Nov. 27.	Com. gurnard,	.	.	.	1	2	2	1	3	2	.	.	.	.	.	.	.	.	.	.	.	
11-38 a.m.	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	
to	Cod,	.	.	.	.	.	2	6	3	2	1	.	.	1	.	.	.	.	2	.	.	
0-45 p.m.	Haddock,	.	.	.	.	.	2	8	1	.	.	.	.	1	1	.	.	.	.	.	.	
	Brassie,	.	.	31	10	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Poor-cod,	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Whiting,	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	
	Hake,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	
	Long rough dab,	1	2	4	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Lemon sole,	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	
	Witch sole,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	
	Piked dog-fish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	
Dec. 21.	Com. gurnard,	.	.	8	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	
0-40 p.m.	Haddock,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	
to	Whiting,	.	.	.	.	.	.	4	.	1	1	.	.	.	.	.	.	.	.	.	.	
2-15 p.m.	Long rough dab,	.	.	12	5	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Witch sole,	.	.	.	.	.	.	1	.	13	5	6	.	1	.	.	.	.	.	.	.	
	Piked dog-fish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	5	2	.	
Station XV.																					
	Cod,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	
June 21.	Haddock,	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
9-50 a.m.	Brassie,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
to	Hake,	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	
11-25 a.m.	Long rough dab,	2	9	27	54	39	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Plaice,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	
	Witch sole,	.	.	.	.	2	14	16	58	70	44	27	8	.	.	.	.	.	.	.	.	
	Piked dog-fish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	
	Fuller's ray,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	

* One 3 inches. † 35 inches. ‡ One 35 inches.

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' DURING 1899.

A. FISH CAUGHT—FIRTH OF CLYDE—*continued.*

tion, , and me wl wn.	Kind of Fish.	Size in Inches. 4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	Total.
tion V.																						
r 27, a.m. o a.m.	Com. gurnard,	.	.	.	.	1	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	2
	Cod,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	*5
	Haddock	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Brassie,	.	2	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
	Whiting,	.	.	.	.	.	1	2	.	.	.	.	.	3	.	.	.	.	.	.	.	3
	Saithe,	.	.	.	.	.	.	.	1	.	2	7	1	.	1	.	1	.	1	.	.	17
	Hake,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
	Long rough dab,	1	13	21	40	34	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	115
	Plaice,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
	Witch sole,	.	.	.	.	.	3	5	23	31	6	8	6	.	.	.	.	.	.	.	.	82
	Herring,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
	Piked dog-fish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	†3
	Grey skate	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1
																						238
. 28. a.m. o a.m.	Com. gurnard,	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	2
	Cod,	.	.	.	2	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	3
	Haddock,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Brassie,	.	.	4	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
	Long rough dab,	11	42	45	85	55	8	.	.	.	.	.	.	1	.	.	.	.	.	.	.	246
	Plaice,	.	.	.	.	.	.	.	2	3	3	6	2	1	.	.	.	1	.	.	.	18
	Witch sole,	.	.	.	.	.	5	34	105	107	70	38	15	.	.	.	.	.	.	.	.	374
	Common dab,	.	.	.	24	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	26
	Conger,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11
																						677
. 18. p.m. o p.m.	Com. gurnard,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Cod,	.	.	.	.	.	.	1	.	.	1	.	.	1	.	.	.	.	.	.	.	3
	Haddock,	.	.	.	.	.	3	1	.	.	1	.	.	1	2	1	.	.	.	.	.	9
	Brassie,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Whiting,	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Long rough dab,	12	24	47	82	55	11	.	.	.	.	.	.	.	.	.	.	.	.	.	.	231
	Plaice,	.	.	.	.	.	.	.	1	1	4	6	2	1	.	1	.	.	.	.	.	16
	Witch sole,	.	.	.	1	1	5	28	43	42	24	12	1	3	.	.	.	.	.	.	.	160
	Herring,	.	.	.	.	.	.	16	17	1	.	.	.	.	.	.	.	.	.	.	.	34
	Piked dog-fish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	9	.	§20
	White skate,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	1	.	.	3
																						480
r. 27. p.m. 30 p.m.	Cod,	.	.	.	.	.	2	.	3	.	.	1	.	.	.	.	.	1	.	3	.	10
	Haddock,	.	.	.	.	.	.	3	.	.	.	.	.	.	.	1	.	.	.	.	.	4
	Brassie,	.	.	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
	Whiting,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Hake,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1
	Long rough dab,	.	5	3	32	15	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	59
	Plaice,	.	.	.	.	.	.	.	.	.	2	2	.	.	.	.	.	.	.	.	.	4
	Witch sole,	.	.	.	.	.	2	9	28	22	13	7	.	2	.	.	.	.	.	.	.	83
	Conger,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	‖1
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	1	.	.	3
																						172
r. 21. a.m. to p.m.	Com. gurnard,	.	.	1	1	.	2	.	.	3	.	.	.	.	.	.	.	.	.	.	.	7
	Haddock,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	1	.	.	3
	Brassie,	.	.	3	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
	Whiting,	.	.	.	.	.	.	3	1	.	.	.	.	.	.	.	.	.	.	.	.	4
	Long rough dab,	.	2	7	14	10	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	35
	Plaice,	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	3
	Witch sole,	.	.	.	.	.	1	19	48	39	29	21	8	.	.	.	.	.	.	.	.	165
	Conger,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	¶1
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1
																						224

* One 28 inches. † One 28 inches. ‡ 35 inches. § Six 26, four 28 inches. ‖ 35 inches. ¶ Over 40 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1899.

A. FISH CAUGHT—Firth of Clyde—*continued.*

Station, Date, and Time Trawl Down.	Kind of Fish.	Size in Inches.																		
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +
Station XVI.																				
May 27. 9-32 a.m. to 11.25 a.m.	Witch sole,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
June 22. 11-10 a.m. to 1-30 p.m.	Haddock,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.
	Brassie,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Witch sole,	.	.	1	.	2	5	29	39	44	19	20	10	1	.	.	.	.	.	.
July 26. 1-25 p.m. to 3-20 p.m.	Haddock,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.
	Witch sole,	.	.	.	.	.	.	.	.	2	1	2	.	.	.	.	.	.	.	.
Sept. 28. 1-6 p.m. to 3.2 p.m.	Haddock,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.
	Saithe,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.
	Long rough dab,	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Witch soles,	.	.	.	.	.	.	.	1	1	1	.	.	.	.	.	.	.	.	.
Oct. 19. 7.20 a.m. to 9.45 a.m.	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Haddock,	.	.	.	.	.	1	2	.	.	.	5	1	2	3	.	.	1	.	1
	Brassie,	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Long rough dab,	.	1	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Witch sole,	.	.	.	.	1	1	11	28	28	23	12	1	.	.	.	.	.	.	.
Nov. 28. 11.55 a.m. to 2.5 p.m.	Cod,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.
	Brassie,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Long rough dab,	.	1	10	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Witch sole,	.	.	.	.	.	1	.	.	2	2	10	3	.	.	.	.	.	.	.
Station XVII.																				
May 27. 6.45 a.m. to 8.0 a.m.	Com. gurnard,	.	.	.	.	3	1	4	.	.	.	.	.	.	.	.	.	.	.	.
	Cod,	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
	Haddock,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.
	Long rough dab,	.	4	2	6	2	3	.	.	.	.	.	.	.	.	.	.	.	.	.
	Plaice,	.	.	.	.	.	.	.	.	1	1	1	1	4	2	1	1	.	.	.
	Lemon sole,	.	.	.	.	.	.	.	.	1	2	1	.	.	.	.	.	.	.	.
	Witch sole,	.	.	.	.	.	1	.	.	4	9	9	3	.	.	.	.	.	.	.
	Common dab,	.	3	3	3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Conger,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1

* 30 inches. † One 30, one 35 inches.

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' DURING 1899.

A. FISH CAUGHT—FIRTH OF CLYDE—*continued.*

ion, , and ne wl m.	Kind of Fish.	SIZE IN INCHES. 4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	Total.
ion II.																						
22. a.m. to a.m.	Com. gurnard,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Cod,	.	.	2	.	2	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	5
	Brassie,	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Whiting,	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	2
	Long rough dab,	3	8	4	8	4	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*29
	Plaice,	.	.	.	.	.	.	.	.	.	1	.	1	1	3	1	.	.	.	.	.	7
	Lemon sole,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
	Witch sole,	.	.	.	.	.	1	.	3	11	15	8	6	2	.	.	.	.	.	.	.	46
	Fuller's ray,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
																						94
26. a.m. to p.m.	Com. gurnard,	.	.	2	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Cod,	.	.	.	1	1	1	.	1	.	.	1	.	.	.	2	2	.	1	.	.	10
	Haddock,	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	2
	Brassie,	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Whiting,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Saithe,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Long rough d ,	5	14	16	15	14	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	†72
	Plaice,	.	.	.	.	.	.	.	.	.	.	1	1	1	1	.	2	.	.	.	.	6
	Witch sole,	.	.	.	.	.	4	7	22	26	24	15	9	4	2	.	.	.	.	.	.	113
	Common dab,	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Conger,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	‡3
	Thornback skate,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
																						217
29. a.m. to a.m.	Com. gurnard,	.	.	.	.	2	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	4
	Cod,	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Haddock,	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	2
	Brassie,	.	1	2	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
	Whiting,	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Saithe,	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1
	Long rough dab,	1	10	4	10	9	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	§39
	Plaice,	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	2
	Witch sole,	.	.	.	.	2	4	6	14	21	25	2	3	2	.	.	.	.	.	.	.	79
	Common dab,	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	White skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1
	Fuller's ray,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1
																						141
24. 7 a.m. to 1 p.m.	Com. gurnard,	.	.	.	1	1	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	4
	Cod,	.	.	.	.	1	1	1	1	1	.	.	.	.	.	.	.	.	.	.	.	5
	Brassie,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Whiting,	.	.	.	.	.	.	2	1	1	.	.	.	.	.	.	.	.	.	.	.	4
	Saithe,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
	Hake,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	1	3
	Long rough dab,	4	35	29	31	31	14	.	.	.	.	.	.	.	.	.	.	.	.	.	.	144
	Plaice,	.	.	.	.	.	.	.	.	1	2	2	3	6	4	.	.	.	.	.	.	18
	Lemon sole,	.	.	.	.	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	3
	Witch sole,	.	.	.	2	.	3	9	18	51	29	21	8	3	1	.	.	.	.	.	.	145
	Common dab,	.	.	1	1	.	5	2	.	.	.	.	.	.	.	.	.	.	.	.	.	9
	Conger,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	‖1
	Thornback skate,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1	2
																						340
27. 10 a.m. to 45 a.m.	Cod,	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1
	Haddock,	.	.	.	.	.	.	2	.	.	.	.	.	.	1	.	.	.	.	.	.	3
	Brassie,	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Saithe,	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	2
	Hake,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1
	Long rough dab,	.	2	7	10	6	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	29
	Plaice,	.	.	.	.	.	.	.	.	3	.	.	1	3	.	.	.	.	.	.	.	7
	Lemon sole,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
	Witch sole,	.	.	.	.	.	.	1	9	11	12	6	7	2	1	.	.	.	.	.	.	49
																						96

* One 3 inches. † Two 3 inches. ‡ One 30, two 35 inches. § One 3 inches. ‖ 35 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 189

A. FISH CAUGHT—Firth of Clyde—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																			T
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
Station XVII.																					
Dec. 21.	Brassie,	.	.	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
8-0 a.m.	Saithe,	.	.	.	.	.	.	.	.	.	.	.	1	3	.	.	.	.	.	.	.	
to	Long rough dab,	.	.	6	15	15	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
9-15 a.m.	Plaice,	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	
	Witch sole,	.	.	.	.	.	.	6	4	2	4	8	2	.	1	.	.	1	.	.	.	
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	

TABLE B.—Record of Observations made on Board the 'Garland' during 1899.

B. PHYSICAL OBSERVATIONS—Firth of Clyde.

Station, Date, and Hour.	End of Station.	Temperature. Air. Dry Bulb.	Temperature. Water. Surface.	Temperature. Water. Bottom.	Temperature. Water. Depth in faths.	Wind. Direction.	Wind. Force.	Weather.	Sea.	Tide.	Barometer.	Transparency. Fathoms.
Station I.												
1899. May 30.												
1.50 p.m.	S.	60·98	50·00	48·9 48·9	19½ 9½	Variable	1	Fine.	Smooth.	3h. 50m. fl.	30·25	9
4.5 p.m.	N.	60·26	50·1	46·6 47·8	22 11	N.W.	3	,,	Slight.	High water	30·24	5
June 7.												
10.20 a.m.	N.	55·76	50·5	46·8 49·3	20 10	W.	5	Fine, haze.	,,	4h. 30m. fl.	30·36	3½
0.7 p.m.	S.	61·88	52·0	47·7	18	Variable	1	Fine.	,,	37 m. ebb.	,,	7½
July 6.												
2.5 p.m.	N.	60·80	55·0	49·1 51·6	21 10½	S.	3	Fine, clear.	Smooth.	3¼ h. ,,	30·22	5
4.3 p.m.	S.	59·72	56·0	49·9	17	,,	4	Fine.	,,	5h.13m.eb.	30·21	5
Sept. 1.												
11.0 a.m.	N.	61·70	56·5	54·5 56·3	21 10½	Variable	..	Fine, cl'dy.	,,	1½ h. ebb.	29·69	5
0.55 p.m.	S.	60·44	56·8	54·7	15	S.	3	Cloudy.	,,	3½ ,,	29·68	6
Oct. 5.												
2.12 p.m.	S.	49·82	54·9	53·3 53·5	16 8	N.	4	Fine.	,,	2 ,,	30·19	5½
4.25 p.m.	N.	50·00	53·4	53·4 53·1	22 11	N.N.W.	2	Fine, clear.	,,	4¼ ,,	30·20	6
Nov. 11.												
0·25 p.m.	S.	53·60	52·0	52·0 51·8	19 9½	S.W.	6	Squally, and rain.	Moderate.	1¾ h. fl.	29·14	3
2.5 p.m.	N.	52·70	51·8	51·6 51·6	32 16	W.	7	Squally, with rain.	Rough.	3½ ,,	29·17	2
Dec. 14.												
12 noon.	N.	39·56	48·1	49·1 48·0	25 12½	S.	5	Cloudy.	,,	2½ h. ebb.	29·67	3½
1.42 p.m.	S.	40·10	48·1	47·0 48·1	21 10½	,,	5	,,	,,	4½ ,,	,,	3½
Station II.												
June 2.												
0.15 p.m.	N.	50·36	49·9	46·8	18	W.N.W.	7	Rain & mist.	Choppy. S. swell.	5¾ h. ebb.	30·5	6
1.35 p.m.	S.	52·88	49·3	47·0 47·5	24½ 12¼	N.W. by W.	7	Dull, cl'dy.	Choppy.	1¾ h. fl.	30·6	4½
July 6.												
11.5 a.m.	N.	61·16	55·9	50·4	17	S.	2	Fine, haze overland.	Smooth.	¼ h. ebb.	30·22	5
1.0 p.m.	S.	63·32	55·6	49·3 53·1	19½ 9¾	,,	2	Fine.	,,	2h.10m. ,,	,,	5
Sept. 1.												
2.30 p.m.	N.	61·16	56·9	54·8	18	S.S.W.	4	Fine, clear.	Slight.	5 h. ebb.	29·68	5½
4.15 p.m.	S.	59·90	57·1	54·5 56·8	22 11	,,	4	Fine, cl'dy.	,,	½ h. fl.	29·66	6
Oct. 5.												
8.0 a.m.	N.	44·96	53·3	52·1	13	N.N.E.	4	Fine, clear.	,,	2 h. ,,	30·16	5
9.40 a.m.	S.	50·00	53·2	53·0 53·0	18 9	,,	4	,,	,,	4 h. ,,	30·18	7
Nov. 9.												
1.45 p.m.	N.	48·92	51·9	51·5 51·8	17 8½	W.N.W.	3	Fine.	Smooth.	4¼ h. ,,	29·79	4
3.37 p.m.	S.	48·92	52·0	51·6	14	S.S.W.	2	Fine, cl'dy.	,,	Near high water.	,,	3
Dec. 14.												
9.7 a.m.	N.	37·76	48·0	49·0 48·3	17 8½	S.S.E.	5	Cloudy.	Rough.	,,	29·65	3½
10.45 a.m.	S.	38·30	47·9	49·2 48·7	23 11½	,,	5	,,	,,	1h.20m.eb.	29·66	3½

TABLE B.—Record of Observations made on Board the 'Garland' during 1899.

B. PHYSICAL OBSERVATIONS.—Firth of Clyde—*continued.*

Station, Date, and Hour.	End of Station.	Temperature. Air. Dry Bulb.	Temperature. Water. Surface.	Temperature. Water. Bottom.	Temperature. Water. Depth in faths.	Wind. Direction.	Wind. Force.	Weather.	Sea.	Tide.	Barometer.	Transparency. Fathoms.
Station III.												
1899. June 1.												
2.10 p.m.	S.	66·99	52·5	47·3 47·8	25 12½	Light S. airs.	..	Fine, haze.	Calm.	2½ h. fl.	30·12	7
4.0 p.m.	N.	62·98	53·8	46·6 47·5	33 16½	S.	1	,,	Smooth.	4½ ,,	30·08	5
July 4.												
1.40 p.m.	N.	59·00	52·0	48·9 50·9	34 17	N.	3	Fine, clear.	Slight.	4h. 40m. eb.	30·14	5
3.12 p.m.	S.	62·24	53·0	47·8 51·5	39 19½	,,	3	,,	Smooth.	Low water.	30·17	4½
Sept. 5.												
3.50 p.m.	N.	60·80	57·6	52·4 57·0	31 15½	W.N.W.	3	,,	Calm.	3¾ h. ebb.	29·90	5
5.40 p.m.	S.	61·70	57·8	52·5 57·1	27 13½	,,	3	,,	,,	5½ ,,	29·92	6
Oct. 4.												
2.0 p.m.	N.	54·50	53·4	53·1 53·3	30 15	N.N.W.	5	Cloudy, fine.	Choppy.	2½ ,,	29·86	5
3.40 p.m.	S.	53·60	53·2	53·1 53·3	26 13	N.	5	Fine, clear.	,,	3¾ ,,	29·90	5
Nov. 9.												
10.55 a.m.	N.	49·28	52·0	52·0 51·6	18 9	W.N.W.	5	Fine, cl'dy.	Slight.	1½ h. fl.	29·77	4
0.56 p.m.	S.	49·82	52·0	52·0 51·6	16 8	,,	4	Fine.	,,	3h. 25m. fl.	29·78	4
Dec. 5.												
0.37 p.m.	N.	47·30	50·2	50·8 50·5	20 10	E.S.E.	3	Continuous rain.	,,	5½ h. fl.	30·05	5
2.35 p.m.	S.	47·48	50·1	50·5 50·2	28 14	,,	2	Overcast, continuous rain.	,,	1½ h. ebb.	30·02	5
Station IV.												
June 2.												
2.50 p.m.	N.E.	51·62	52·3	46·5 50·6	27 13½	N.W.	5	Dull, cl'dy.	Choppy.	2¾ h. fl.	30·10	7
3.45 p.m.	S.W.	50·90	52·1	47·1 48·2	20 10	,,	5	Cloudy, bright at intervals.	,,	3¾ ,,	30·11	7
July 6.												
8.45 a.m.	N.E.	59·36	55·8	49·9 52·0	25 12½	Variable	1	Fine. cl'dy.	Calm.	4 ,,	30·21	5
9.58 a.m.	S.W.	62·24	56·00	51·0 52·0	25 12½	S.	1	Fine.	Smooth.	5½ ,,	30·22	5
Sept. 2.												
6.55 a.m.	S.W.	55·40	57·5	54·5 57·1	21 10½	Variable	1	Showery.	,,	3 ,,	29·64	8
7.52 a.m.	N.E.	56·12	57·6	54·5 56·8	25 12½	,,	1	,,	,,	4 ,,	,,	7
Oct. 4.												
0.35 p.m.	N.E.	52·52	53·2	53·5 53·4	20 10	N.W.	5	Fine, clear.	Slight.	1 h. ebb.	29·84	4
1.30 p.m.	S.W.	54·32	53·2	53·5 53·3	18 9	,,	4	,,	,,	2 ,,	29·85	5
Nov. 9.												
9.20 a.m.	N.E.	47·12	52·0	52·0 51·8	23 11½	W.	4	Fine, cl'dy.	Smooth.	6 ,,	29·74	4
10.2 a.m.	S.W.	49·28	51·6	51·8 51·6	18 9	W.N.W.	4	,,	Slight.	¾ h. fl.	29·76	4
Dec. 5.												
10.53 a.m.	N.E.	47·84	50·2	50·4 50·5	24 12	Variable	1	Overcast, continuous rain.	Westerly Swell.	3¾ ,,	30·08	5
12 noon.	S.W.	48·74	50·2	49·2	15	,,	1	Overcast, continuous rain.	Calm.	4h. 50m. fl.	30·6	4

TABLE B.—Record of Observations made on Board the 'Garland' during 1899.

B. PHYSICAL OBSERVATIONS—Firth of Clyde—*continued.*

Station, Date, and Hour.	End of Station.	Temperature. Air. Dry Bulb.	Temperature. Water. Surface.	Temperature. Water. Bottom.	Temperature. Water. Depth in faths.	Wind. Direction.	Wind. Force.	Weather.	Sea.	Tide.	Barometer.	Transparency. Fathoms.
Station V.												
1899. June 1.												
10.40 a.m.	N.	60·80	50·0	47·7	19	..	..	Fine, slight haze.	Calm.	..	30·16	6
0.4 p.m.	S.	65·48	50·0	48·1	15½	..	..	,,	,,	½ h. fl.	30·15	5
July 4.												
9.55 a.m.	N.	57·38	54·6	51·9	18	N.N.W.	4	Fine, clear.	Smooth.	1 h. ebb.	30·12	4
				53·7	9							
11.10 a.m.	S.	60·80	54·9	53·7	18½	N.	3	Fine.	,,	2h.10m.eb.	30·13	3½
Sept. 8.												
3.45 p.m.	N.	60·44	59·0	57·0	17	N.N.W.	4	Fine, clear.	Slight.	2½ h. ,,	30·10	6
4.58 p.m.	.	58·64	59·1	57·0	19	,,	5	Cloudy.	,,	3½ h. fl.	30·11	7
Oct. 11.												
12 noon.	S.	56·12	54·0	53·9	15	S.W.	5	Rain, overcast.	Choppy.	2h. 20m. fl.	29·76	5½
1.5 p.m.	N.	56·30	54·0	53·7	20	,,	6	Overcast.	Slight.	3h. 25m. ,,	29·72	5
				53·7	10							
Nov. 17.												
9.35 a.m.	S.	50·00	51·3	51·1	18	..	..	,,	Smooth.	4½ h. fl.	30·64	4½
				51·0	9							
10.40 a.m.	N.	50·36	51·1	51·5	19	Variable	1	Fine, haze.	,,	5½ ,,	30·66	4
Dec. 18,												
2.43 p.m.	S.	43·70	48·3	48·3	16½	S.S.E.	4	Overcast.	Choppy.	2h.20m.eb.	30·05	4
3.50 p.m.	N.	43·70	49·2	48·3	21	,,	4	,,	Slight.	4½ h. ,,	,,	5
				48·5	10½							
Station VI.												
May 30.												
11.25 a.m.	S.	56·84	50·0	48·4	25	S.W.		Fine, slight haze.	Slight.	1h. 25m. fl.	30·26	8
				48·2	12½							
1.27 p.m.	N.	59·00	49·0	48·2	23	..	..	Fine.	Calm.	3h. 25m. ,,	30·25	7½
				48·8	11½							
June 7.												
0.43 p.m.	N.	60·08	52·0	49·8	21	S.	1	Fine, slight haze.	Smooth.	1¼ h. ebb.	30·37	7
				50·0	10½							
2.40 p.m.	S.	66·56	53·5	49·7	22	Variable	1	Fine.	,,	3h. 10m. ,,	,,	7
				49·8	11							
July 7.												
8.25 a.m.	N.	59·90	52·4	50·9	22	S.S.W.	1	Fine.	Calm.	2h. 50m. fl.	30·20	4½
				51·5	11							
10.30 a.m.	S.	59·36	53·1	52·2	25	,,	3	Overcast.	Smooth.	4h. 55m. ,,	,,	4
				52·8	12½							
Sept. 6.												
7.50 a.m.	N.	55·58	56·0	54·9	21	N.W.	2	Fine.	,,	1h. 20m. ,,	29·97	5
				55·1	10½							
10.5 a.m.	.	62·24	56·9	55·7	26½	W.	1	,,	,,	3½ h. fl.	30·00	5
				56·1	13¾							
Oct. 5.												
11.48 a.m.	S.	51·44	55·0	55·0	25	N.N.E.	3	Fine, clear.	Slight.	5¾ ,,	30·20	6
				54·9	12½							
1.48 p.m.	N.	50·54	54·0	54·3	23	N.	4	,,	Calm.	1¾ h. ebb.	30·19	6
				54·1	11½							
Nov 14.												
8.50 a.m.	N.	53·60	51·3	52·0	20	S.S.W.	4	Overcast, continuous rain.	Southerly swell.	High water.	29·90	3
				51·9	10							
10.53 a.m.	S.	53·42	51·3	52·2	27	,,	4	Overcast, rain.	Heavy southerly swell.	2h. ebb.	29·92	4
				51·5	13½							
Dec. 6.												
1.15 p.m.	S.	51·08	51·0	51·4	25	S.S.E.	5	Mist, and fine rain.	Rough.	5h. 20m. fl.	29·66	4
				51·3	12½							
3.15 p.m.	N.	51·08	51·0	51·0	20	S.E.	4	,,	,,	1¼ h. ebb.	29·62	3½
				51·0	10							

TABLE B.—Record of Observations made on Board the 'Garland' during 1899.

B. PHYSICAL OBSERVATIONS.—Firth of Clyde—*continued.*

Station, Date, and Hour.	End of Station.	Temperature.				Wind.		Weather.	Sea.	Tide.	Barometer.	Transparency. Fathoms.
		Air.	Water.									
		Dry Bulb.	Surface.	Bottom.	Depth in faths.	Direction.	Force.					
Station VII. 1899.												
May 29.												
9.15 a.m.	N.E.	56·30	52·0	47·4	18	..	..	Fine, slight haze.	Smooth.	Lowwater.	30·41	5
11.15 a.m.	S.W.	62·60	57·4	47·6	18	S.W.	1	,,	,,	1¾ h. fl.	30·40	4½
June 7.												
6.10 p.m.	N.E.	58·64	50·9	47·3	21	Variable	1	Fine.	Calm, S.W. swell.	25 m. fl.	30·36	5
				47·1	10½							
8.5 p.m.	S.W.	55·04	54·6	48·0	24	W.	1	Fine, sweltering fog.	Choppy.	2h.20m. ,,	30·36	5
				47·5	12							
June 15.												
9.35 p.m.	S.W.	59·18	56·0	48·8	24	,,	1	Fine, hazy.	Smooth.	5 h. ebb.	30·11	..
				48·8	12							
11.45 p.m.	N.E.	58·82	60·2	48·8	20	,,	1	Fine, starlight.	,,	1¼ h. fl.	30·12	..
				48·0	10							
July 7.												
4.12 p.m.	N.E.	60·80	57·9	50·2	22	S.S.W.	4	Showery.	Slight.	4½ h. ebb.	30·18	5
				50·8	11							
6.20 p.m.	S.W.	60·26	58·9	51·0	19	,,	4	,,	,,	½ h. fl.	,,	5
				51·2	9½							
July 19.												
9.30 p.m.	N.E.	59·90	58·1	51·5	24	..	..	Fine.	Smooth.	1 h. ebb.	30·0	..
				55·1	12							
11.35 p.m.	S.W.	59·00	59·3	52·1	19	N.W.	1	Fine, moonlight.	Calm.	3 ,,	30·2	..
Sept. 12.												
10.20 a.m.	N.E.	60·80	57·8	56·8	17	S.S.W.	2	Fine, cl'dy.	Smooth.	½ h. fl.	30·11	5
0.25 p.m.	S.W.	60·80	58·0	57·1	12	S.W.	4	Overcast.	Slight.	2½ h. ,,	,,	6
Oct. 6.												
3.53 p.m.	N.E.	52·16	54·4	54·7	23	,,	1	,,	Smooth.	3¼ h. ebb.	30·16	5½
				54·4	11½							
5.55 p.m.	S.W.	51·62	54·7	55·0	16	..	..	Fine.	Quite smooth.	5¼ ,,	,,	5
Nov. 15.												
2.10 p.m.	N.E.	49·64	52·3	53·0	23	E.	2	Overcast.	Calm, E. swell.	4½ ,,	30·57	3
				52·9	11½							
4.15 p.m.	S.W.	50·00	52·0	52·9	14	,,	1	,,	Calm.	First of flood.	30·60	3
Dec. 12.												
8.2 a.m.	S.W.	39·20	50·0	48·6	12	E.S.E.	4	Cloudy.	N.W.swell.	1½ h. ebb.	49·77	2
10.0 a.m.	N.E.	38·84	50·2	52·2	25	N.E.	3	Fine.	Slight.	3½ ,,	29·82	3
				49·9	12½							
Station VIII.												
May 29.												
0.50 p.m.	W.	58·28	50·0	48·4	35	S.W.	1	Fine, slight haze.	Smooth.	3½ h. fl.	33·38	5
				48·3	17½							
3.5 p.m.	E.	59·36	51·7	48·0	30	,,	2	,,	Slight.	5½ ,,	30·38	8
				48·7	15							
June 8.												
11.15 a.m.	W.	56·48	52·0	48·5	34½	N.N.E.	2	Overcast.	Calm, S.W.swell.	5½ ,,	30·45	4
				49·6	17¼							
1.20 p.m.	E.	57·02	52·3	48·6	28	N.E.	1	Dull, hazy.	Slight.	1h.20m.eb.	,,	5½
				50·0	14							
June 13.												
9.40 p.m.	W.	55·22	55·2	49·0	32½	S.W.	2	Fine.	Smooth.	½ h. fl.	30·13	..
				49·1	16½							
0.20 a.m.	E.	55·94	55·4	49·0	28½	,,	1	Fine, starlight.	Calm.	2¾ ,,	30·12	..
				49·0	14¼							
July 7.												
11.55 a.m.	W.	59·00	57·00	51·2	34½	S.S.W.	4	Dull, cl'dy.	Slight.	20m. ebb.	30·20	5
				51·6	17¼							
2·13 p.m.	E.	60·08	56·3	51·1	29	,,	4	,,	,,	2½ h. ,,	30·18	5
				51·8	14½							

TABLE B.—Record of Observations made on Board the 'Garland' during 1899.

B PHYSICAL OBSERVATIONS.—Firth of Clyde—*continued.*

Station, Date, and Hour.	End of Station.	Temperature.				Wind.		Weather.	Sea.	Tide.	Barometer.	Transparency. Fathoms.
		Air.	Water.									
		Dry Bulb.	Surface.	Bottom.	Depth in faths.	Direction.	Force.					
Station VIII.												
1899. July 21.												
8.45 p.m.	W.	59·54	57·2	52·0 54·0	35 17½	N.E.	2	Dull, mist.	Smooth.	4¼ h. fl.	30·09	..
11.7 p.m.	E.	59·00	57·6	51·5 53·0	28 14	N.E.	2	Dull.	Calm.	¼ h. ebb.	30·10	..
Sept. 13.												
0.27 p.m.	E.	59·00	57·3	57·0 57·1	29 14½	N.	4	Fine, clear.	Choppy.	1h.51m.fl.	,,	6
2.30 p.m.	W.	59·54	57·7	57·0 57·1	35 17½	N.N.W.	5	,,	,,	3h.40m. ,,	30·09	7
Oct. 10.												
7.55 a.m.	W.	55·40	54·0	55·6 54·5	38 19	S.W.	4	Overcast.	Slight.	5¼ h. ebb.	30·10	10
10.0 a.m.	E.	57·56	54·0	54·5 53·4	26 13	S.W.	3	Fine, haze.	Smooth, S.W.swell.	1¼ h. fl.	30·11	7
Nov. 23.												
7.43 a.m.	W.	50·00	52·0	52·3 52·0	35 17½	W.S.W.	6	Overcast.	Rough.	4½ h. ebb.	30·18	3
10.5 a.m.	E.	50·90	51·2	52·9 52.2	30 15	S.W.	6	Cloudy.	,,	¾ h. fl.	30·17	5
Dec. 12.												
0.20 p.m.	E.	39·74	50·0	50·1 50·0	26 13	N.E.	2	Fine.	Slight.	5¾ h. ebb.	29·84	3½
2.30 p.m.	W.	41·00	49·7	51·2 53·5	35 17½	N.E.	3	,,	,,	1 h. fl.	,,	3½
Station IX.												
May 29.												
4.3 p.m.	S.W.	57·20	50·0	48·0 48·4	29 14½	S.W.	2	Fine, haze.	Smooth.	¼ h. ebb.	30·36	7
6.10 p.m.	N.E.	58·82	51·5	48·0	27	S.W.	1	Fine.	,,	2h.40m.eb.	30·35	6½
June 8.												
2.15 p.m.	S.W.	59·36	53·0	48·7 49·0	28½ 14	..	..	Fine, cl'dy.	,,	2¼ h. ebb.	34·4	6
4.30 p.m.	N.E.	62·24	53·0	48·7 51·5	27 13½	Variable	1	Fine, hazy.	,,	4½ ,,	30·44	7
July 8.												
10.25 a.m.	S.W.	57·56	56·3	51·1 53·5	30 15	N.W.	4	Fine, clear.	Slight.	3½ h. fl.	30·16	5½
11.50 a.m.	N.E.	59·18	58·0	51·2 51·4	27 13½	N.W.	4	Fine.	,,	5h.40m. ,,	30·15	5½
Sept. 8.												
9.35 a.m.	N.E.	55·40	58·0	52·8 54·7	28 14	N.N.W.	4	Cloudy, passing showers.	Choppy.	2 h. fl.	30·08	7
11.55 a.m.	S.W.	60·44	57·5	54·5 56·8	28 14	N.N.W.	2	Fine.	Calm.	4½ ,,	30·09	7
Oct. 10.												
11.35 a.m.	S.W.	57·56	53·9	55·0 53·5	28 14	S.W.	3	Fine, haze.	Slight.	2h.35m. ,,	30·10	7
1.40 p.m.	N.E.	56·84	54·0	54·0 53·5	28 14	S.S.W.	2	Overcast, fine rain.	,,	4h.50m. ,,	30·9	7
Nov. 15.												
9.50 a.m.	N.E.	46·22	51·2	51·5 51·1	30 15	E.	6	Cloudy.	Moderate, choppy.	Top of high water	30·56	4
12 noon.	S.W.	47·48	51·5	52·0 51·3	28 14	E.N.E.	5	Overcast.	Moderate, choppy.	2h.20m.eb.	30·57	3½
Dec. 13.												
8.55 a.m.	N.E.	38·30	50·0	50·5 50·0	26 13	S.S.E.	5	,,	Rough.	¾ h. ebb.	29·49	3½
11·8 a.m.	S.W.	38·84	49·1	50·2 49·2	29 14½	S.S.E.	6	,,	,,	3 ,,	29·44	4

TABLE B.—Record of Observations made on Board the 'Garland' during 1899.

B. PHYSICAL OBSERVATIONS—Firth of Clyde—*continued.*

Station, Date, and Hour.	End of Station.	Temperature.				Wind.		Weather.	Sea.	Tide.	Barometer.	Transparency. Fathoms.
		Air.	Water.									
		Dry Bulb.	Surface.	Bottom.	Depth in faths.	Direction.	Force.					
Station X.												
1899. May 30.												
8.0 a.m.	N.E.	53·60	50·6	48·1 47·8	29 14½	S.W.	2	Fine, hazy.	Smooth.	4 h. ebb.	30·29	8
10.15 a.m.	S.W.	54·86	49·5	48·1 48·4	27 13½	S.W.	2	Fine, haze.	,,	15 m. fl.	30·26	8
June 13.												
4.30 p.m.	N.E.	59·18	57·3	49·8 51·3	28 14	W.S.W.	3	,,	Slight.	1½ h. ebb.	30·13	5
6.45 p.m.	S.W.	59·00	56·0	49·5 50·1	26 13	W.S.W.	3	Fine.	,,	3¾ ,,	,,	6
July 19.												
11.45 a.m.	N.E.	60·80	57·3	50·8 52·4	25 12½	S.	...	Fine, haze.	Smooth.	3h.50m. ,,	29·94	7
2.0 p.m.	S.W.	62·78	54·7	51·8 52·0	25 12½	S.	1	,,	,,	Low water	29·95	5
Sept. 6.												
4.2 p.m.	N.E.	66·56	58·0	53·2 56·5	27 13½	N.W.	4	Fine, clear.	Slight.	3h.25m.eb.	30·00	7
6.0 p.m.	S.W.	62·24	57·8	56·2 56·5	26 13	N.W.	2	Fine.	Smooth.	5½ h. ,,	,,	6
Oct. 9,												
10.57 a.m.	S.W.	54·68	54·9	55·4 55·3	27 13½	S.W.	4	Overcast.	Slight.	2¾ h. fl.	30·20	7
1.15 p.m.	N.E.	55·76	53·9	53·8 53·4	28 14	S.S.W.	4	Overcast, haze.	Choppy.	5 ,,	30·16	7
Nov. 14.												
11.28 a.m.	S.W.	53·24	52·0	51·9 51·8	25 12½	S.S.W.	4	Overcast.	Heavy S.W.swell.	2h.40m.eb.	29·93	3½
1.45 p.m.	N.E.	53·42	51·6	51·8 51·5	27 13½	W.	1	Cloudy.	Southerly swell.	5 h. ebb.	29·97	3½
Dec. 6.												
8.50 a.m.	N.E.	51·62	50·6	50·7 50·5	23 11½	S.	4	Fine rain.	Choppy.	1 h. fl.	29·74	5
11.10 a.m.	S.W.	51·08	50·6	50·9 50·4	30 15	S.S E	3	Misty.	Rough.	3h. 20m. fl.	29·72	5
Station XI.												
May 31.												
12 noon.	S.W.	62·96	50·5	47·2 47·0	35 17½	..	..	Fine, haze.	Calm.	1 h. fl.	30·26	4
1.45 p.m.	N.E.	66·20	53·00	46·8	17	..	..	,,	,,	2¾ ,,	,,	5
June 1.												
7.10 a.m.	N.E.	57·20	50·2	46·9 47·2	25 12½	E.	1	,,	Smooth.	1½ h. ebb.	30·20	5
9.20 a.m.	S.W.	61·16	52·2	47·1 46·4	35 17½	E.	1	,,	,,	3¾ ,,	30·17	4½
July 4.												
6.40 a.m.	N.E.	53·24	51·8	49·1 49·8	24 12	N.W.	4	Fine, cl dy.	Choppy.	4 h. fl.	30·11	5
8.25 a.m.	S.W.	56·48	53·7	49·3 48·8	32 16	N.N.W.	4	Fine.	Slight.	5¾ ,,	30·12	5
Sept. 15.												
8.19 a.m.	N E.	52·70	57·4	54·5 57·0	25 12½	S.S.W.	5	Overcast, continuous rain.	Choppy.	1 h. ebb.	29·92	7½
10.15 a.m.	S.W.	55·22	57·8	55·7 57·4	35 17½	S.S.W.	6	Continuous rain.	Rough.	3 ,,	29·83	7
Oct.												
9.0 a.m.	N.E.	51·08	54·0	53·7 53·5	28 14	W.N.W.	5	Cl'dy, rain.	Choppy.	4h.40m. ,,	29·46	5½
10.47 a.m.	S.W.	52·16	54·0	54·0 53·7	33 16	N.W.	6	Cloudy.	,,	10 m. fl.	,,	5
Nov. 20.												
1.53 p.m.	N.E.	50·00	50·4	51·8 51·0	25 12½	E.N.E.	1	Fine, haze.	Smooth.	½ h. ebb.	30·30	4
3.30 p.m.	S.W.	49·10	50·2	51·5 51·0	30 15	E.N.E.	3	,,	Slight.	2h.20m. ,,	,,	4

TABLE B.—Record of Observations made on Board the 'Garland' during 1899.

B. PHYSICAL OBSERVATIONS—Firth of Clyde—*continued.*

Station, Date, and Hour.	End of Station.	Temperature.				Wind.		Weather.	Sea.	Tide.	Barometer.	Transparency. Fathoms.
		Air.	Water.									
		Dry Bulb.	Surface.	Bottom.	Depth in faths.	Direction.	Force.					
1899.												
Dec. 15.												
1.23 p.m.	S.W.	41·72	49·1	50·9	31	S.S.W.	5	Overcast.	Rough.	3 h. ebb.	29·78	4
				49·3	15½							
3.17 p.m.	N.E.	43·16	49·0	49·0	25	,,	6	,,	Very rough.	5 ,,	29·75	4
				49·0	12½							
Station XII.												
May 31.												
8.30 a.m.	W.	57·74	50·4	46·2	42½	..	..	Fine, slight haze.	Calm.	3½ ,,	30·26	4½
				46·9	21½							
10.55 a.m.	E.	64·76	51·3	46·8	34	,,	..	Fine.	,,	About low water.	30·27	5½
				47·0	17							
June 12.												
10.5 p.m.	E.	59·00	57·8	47·2	33½	S.W.	2	Fine, cl'dy.	Slight.	1½ h. fl.	30·12	..
				47·8	16½							
0.45 a.m.	W.	59·00	56·8	48·6	44	Variable	..	Fine.	Calm.	4 ,,	,,	..
				46·8	22							
June 17.												
7.30 a.m.	E.	56·66	59·2	48·7	35	N.E.	2	Dull and misty.	Smooth	1½ h. ebb.	30·03	5½
				48·0	17½							
9.58 a.m.	W.	59·90	59·2	48·8	43	,,	2	Fine, misty.	,,	4 ,,	30·01	6
				49·0	21½							
July 18.												
8.50 p.m.	E.	59·36	59·1	48·0	35	S.	1	Heavy rain.	,,	1½ ,,	29·99	..
				51·0	17½							
11.15 p.m.	W.	57·56	56·3	48·0	42	,,	2	Continuous rain.	Calm.	3h. 50m. ,,	29·96	..
				50·0	21							
July 24.												
3.15 p.m.	E.	59·90	55·5	50·9	33	N.W.	4	Fine, clear.	Choppy.	2 h. ebb.	30·6	4½
				50·3	16½							
5.25 p.m.	W.	59·54	58·2	50·4	40	,,	4	Cloudy.	Slight.	4h.10m. ,,	30·08	5
				49·0	20							
Sept. 14.												
8.33 a.m.	E.	58·28	58·0	52·7	33	W.S.W.	5	Dull and cloudy.	Choppy.	2h.40m. ,,	30·02	5
				56·5	16½							
10.46 a.m.	W.	60·08	58·1	51·0	39	N.W.	4	Fine.	Slight.	5 h. ebb	,,	8
				53·1	19½							
Oct. 12.												
11.7 a.m.	E.	51·80	53·9	54·3	34½	,,	6	Cloudy.	Choppy.	½ h. fl.	29·46	5
				53·7	17½							
1.27 p.m.	W.	51·44	53·8	53·8	37	,,	6	Squally.	Rough.	2h.50m. ,,	,,	4
				54·0	18½							
Nov. 25.												
7.53 a.m.	E.	51·62	51·9	52·0	35	W.	4	Overcast.	Slight.	½ h. ebb	30·17	6
				50·9	17½							
10.15 a.m.	W.	51·62	50·5	52·4	47	S.W.	3	Fine, cl'dy.	,,	5½ ,,	30·20	6
				50·5	23½							
Dec. 18.												
10.45 a.m.	E.	41·36	49·0	49·6	34	S	2	Overcast.	Calm.	4½ h. fl.	30·09	4½
				49·0	17							
1.0 p.m.	W.	43·16	49·0	49·6	45	,,	4	,,	Slight.	40 m. ebb	30·07	3½
				49·3	22½							
Station XIII.												
May 26.												
9.35 a.m.	S.W.	51·98	47·8	46·2	25	S.W.	2	Fine, cl'dy.	Smooth.	3 h. fl.	30·14	5½
11.0 a.m.	N.E.	53·24	48·1	46·7	34½	,,	2	,,	,,	4½ ,,	30·16	5½
				47·3	17¼							
June 20.												
0.35 p.m.	S.W.	54·50	51·9	46·9	34	E.S.E.	4	Cloudy.	,,	5 h. ebb.	29·52	4
				48·2	17							
2.0 p.m.	N.E	55·58	53·1	47·4	36	Variable	1	Dull and showery.	,,	3½ ,,	29·53	4
				48·0	18							

TABLE B.—Record of Observations made on Board the 'Garland' during 1899.

B. PHYSICAL OBSERVATIONS—Firth of Clyde—*continued.*

Station, Date, and Hour.	End of Station.	Temperature.				Wind.		Weather.	Sea.	Tide.	Barometer.	Transparency. Fathoms.
		Air.	Water.									
		Dry Bulb.	Surface.	Bottom.	Depth in faths.	Direction.	Force.					
1899.												
July 27.												
2.0 p.m.	N.E.	57·92	52·2	48·5 50·0	35 17½	W.N.W.	5	Cloudy.	Slight.	4h. 50m. fl.	30·27	5
3.30 p.m.	S.W.	57·38	51·9	49·0 50·0	27 13½	,,	5	,,	Smooth.	Just after high w ter.	,,	4
Sept. 27.												
0.45 p.m.	S.W.	54·86	51·9	51·7 51·9	23 11½	N.N.W.	4	Fine, passing showers.	,,	1½ h. fl.	29·43	5
2.10 p.m.	N.E.	53·96	53·00	52·0 51·9	35 17½	,,	2	,,	,,	2h. 40m. fl.	29·42	5½
Oct. 18.												
8.27 a.m.	S.W.	55·4	51·8	51·7 51·7	28 14	S.	2	Overcast.	Calm.	3h. 40m. ,,	30·20	5
9.55 a.m.	N.E.	55·22	52·0	52·0 51·7	35 17½	Calm.	..	Misty, overcast.	Smooth.	5 h. fl.	30·22	5½
Nov. 27.												
10.0 a.m.	S.W.	51·08	50·0	51·9 51·3	31 15½	W.	5	Showery.	Slight.	3 h. ebb.	30·18	4
11.27 a.m.	N.E.	51·26	51·0	52·0 51·5	34 17	W.S.W.	5	Cloudy.	,,	4h. 40m. ,,	30·19	4½
Dec. 20.												
8.47 a.m.	S.W.	39·20	47·2	47·8 47·3	23 11½	E.S.E.	6	Dull, continuous rain.	,,	1 h. fl.	30·10	3½
10.20 a.m.	N.E.	39·20	47·0	48·2 46·9	28 14	,,	6	,,	,,	2½ ,,	30·12	3½
Station XIV.												
May 26.												
0.25 p.m.	N.E.	56·84	48·4	46·9 47·3	31 15½	S.W.	2	Fine, bright.	Smooth.	5¼ ,,	30·16	6
June 20.												
11.10 a.m.	N.E.	58·10	54·8	47·6 48·1	25 12½	E.N.E.	2	Cloudy, dull.	,,	2½ h. ebb	29·53	4½
0.35 p.m.	S.W.	55·58	53·1	47·4 48·0	36 18	Variable	1	Dull and raining.	,,	3¼ ,,	,,	4
July 27.												
11.55 a.m.	N.E	57·92	53·2	49·2 50·0	23 11½	W.	5	Showery.	Slight.	2¾ h. fl.	30·25	4
2.0 p.m.	S.W.	57·92	52·2	48·5 50·0	35 17½	W.N.W.	5	Cloudy.	,,	4h. 50m. ,,	30·27	5
Sept. 27.												
2.10 p.m.	S.W.	53·96	53·0	52·0 51·9	35 17½	N.N.W.	2	Fine, passing showers.	Smooth.	2h. 40m. ,,	29·42	5½
4.10 p.m.	N.E.	53·96	52·4	51·9 52·0	30 15	N.	3	Fine.	Calm.	4h. 40m. ,,	29·45	4
Oct. 18.												
9.55 a.m.	S.W.	55·22	52·0	52·0 51·7	35 17½	Calm.	..	Mist, overcast.	,,	5 h. fl.	30·22	5½
11.30 a.m.	N.E.	55·58	51·6	52·0 51·8	27 13½	Variable	1	,,	Smooth.	25m. ebb.	30·23	7
Nov. 27.												
11.27 a.m.	S.W.	51·26	51·0	52·0 51·5	34 17	W.S.W.	5	Cloudy.	Slight.	4h. 40m. ,,	30·19	4½
1.5 p.m.	N.E.	50·18	50·9	51·9 50·5	30 15	,,	5	,,	,,	Low water.	,,	5
Dec. 21.												
0.35 p.m.	N.E.	42·26	45·0	48·0 47·2	25 12½	E.	2	,,	Ripple.	4 h. fl.	30·30	4½
2.20 p.m.	S.W.	41·72	45·7	48·0 48·1	30 15	,,	2	Overcast.	Smooth.	5¼ ,,	30·29	5

TABLE B.—Record of Observations made on Board the 'Garland' during 1899.

B. PHYSICAL OBSERVATIONS.—Firth of Clyde—*continued.*

Station, Date, and Hour.	End of Station.	Temperature.				Wind.		Weather.	Sea.	Tide.	Barometer.	Transparency. Fathoms.
		Air.	Water.									
		Dry Bulb.	Surface.	Bottom.	Depth in faths.	Direction.	Force.					
Station XV.												
1899. June 21.												
9.43 a.m.	S.W.	61·70	57·2	48·0 48·5	34 17	N.E.	4	Cloudy.	Slight.	5¼ h. fl.	29·62	5½
11.35 a.m.	N.E.	65·66	59·2	48·1 47·5	35 17½	,,	2	,,	Smooth.	1h.35m.eb.	29·64	5
July 27.												
9.55 a.m.	N.E.	57·74	54·0	48·0 52·1	36½ 18¼	W.	5	Cloudy, passing showers.	Slight.	¾ h. fl.	30·23	3
11.27 a.m.	S.W.	57·74	54·0	48·0 52·0	32 16	,,	5	Showery.	Smooth.	2¼ ,,	30·24	4
Sept. 28.												
8.6 a.m.	S.W.	44·06	49·1	51·4 51·9	35 17½	E.N.E.	2	Fine.	,,	1h.40m.eb.	29·63	3½
10.0 a.m.	N.E.	46·04	47·9	48·7 51·7	42 21	,,	1	Fine, cl'dy.	Quite calm.	3h.35m. ,,	29·64	3½
Oct. 18.												
12 noon.	S.W.	56·30	51·4	51·0 51·6	34 17	S.S.W.	2	Overcast.	Calm.	55 m. fl.	30·23	5
1.40 p.m.	N.E.	57·38	51·8	49·8 51·4	40 20	,,	4	,,	Smooth.	2h.35m.eb.	30·22	6
Nov. 27.												
2.17 p.m.	S.W.	52·70	50·4	52·0 50·6	30 15	W. by S.	5	Showery.	Slight.	1¼ h. fl.	30·19	5
4.5 p.m.	N.E.	51·62	50·0	50·5 50·2	40 20	W.	6	Overcast, continuous rain.	,,	3 ,,	30·20	3½
Dec. 21.												
10 50 a.m.	N.E.	41·54	45·0	48·0 47·2	25 12½	E.	2	Cloudy.	Ripple.	2¼ ,,	30·30	4
0.18 p.m.	S.W.	41·72	44·0	50·0 47·8	33 16½	,,	2	,,	,,	3¼ ,,	,,	4
Station XVI.												
May 27.												
9.5 a.m.	N.E.	52·52	48·4	46·7 46·1	53 26½	..	..	Fine, clear.	Calm.	1½ h. fl.	30·33	5
10.40 a.m.	S.W.	59·90	49·0	46·7 46·0	61 30½	,,	..	,,	,,	3½ ,,	30·38	5
June 22.												
8.17 a.m.	N.E.	59·00	49·0	47·0 46·9	63 31½	N.E.	1	Dull, cl'dy.	,,	3h.40m. ,,	29·80	3
10.55 a.m.	S.W.	59·90	53·0	47·4 47·6	68 34	S.E.	3	,,	Smooth.	High water	29·82	4
July 26.												
1.20 p.m.	N.E.	58·96	56·2	47·9 47·7	61 30½	W.	6	Fine, cl'dy.	Slight.	5 h. fl.	30·07	2
3.40 p.m.	S.W.	58·82	55·0	47·9 50·3	51 25½	,,	6	Fine.	Choppy.	1h. 5m. eb.	30·10	3
Sept 28.												
1.0 p.m.	S.W.	53·24	51·0	48·0 51·5	62 31	W.S.W.	2	Fine, clear.	Quite calm.	½ h. fl.	29·67	5
3.15 p.m.	N.E.	56·30	56·3	48·0 51·0	60 30	S.W.	1	,,	,,	2½ ,,	29·68	5
Oct. 19.												
7.15 a.m.	S.W.	50·36	51·1	48·0 48·2	62 31	Calm.	..	Fine, haze.	Smooth.	1h. 20m. fl.	30·27	5½
10.7 a.m.	N.E.	54·32	52·0	48·0 51·1	60 30	,,	..	,,	,,	4¼ h. fl.	30·28	5
Nov. 28.												
11.47 a.m.	N.E.	50·00	49·7	49·0 49·8	60 30	S.W.	7	Squally, continuous rain.	Choppy.	3¾ h. ebb.	30·18	2½
2.15 p.m.	S.W.	51·62	48·0	50·5 50·0	66 33	,,	6	,,	,,	Low water.	30·20	4

TABLE B.—Record of Observations made on Board the 'Garland' during 1899.

B. PHYSICAL OBSERVATIONS—Firth of Clyde—*continued.*

Station, Date, and Hour.	End of Station.	Temperature. Air. Dry Bulb.	Temperature. Water. Surface.	Temperature. Water. Bottom.	Depth in faths.	Wind. Direction	Wind. Force.	Weather.	Sea.	Tide.	Barometer.	Transparency. Fathoms.
Station XVII.												
1899.												
May 27.												
6.40 a.m.	N.E.	42·62	48·9	47·4	13	Calm.	..	Fine, clear.	Smooth.	5 h. ebb.	30·33	5
8.16 a.m.	S.W.	50·18	48·0	47·4	35	..	..	,,	Calm.	½ h. fl.	,,	4½
				46·6	17½							
June 23.												
10.10 a.m.	N.E.	60·80	47·8	46·5	12½	Variable	1	Cloudy.	Smooth.	4h. 40m. fl.	29·92	5
11.40 a.m.	S.W.	59·72	48·0	47·2	33	,,	1	Dull, cl'dy.	,,	High water	,,	4½
				46·7	16½							
July 26.												
7.25 a.m.	N.E.	55·04	57·9	57·4	13	W.	6	Fine, cl'dy.	Slight.	5h. 10m. eb.	30·00	2 ft.
9.10 a.m.	S.W.	58·10	56·2	55·9	34	W.S.W.	6	,,	,,	¾ h. fl.	,,	4 ,,
				56·1	17							
Sept. 29.												
6.13 a.m.	N.E.	41·00	50·1	48·2	13	Variable	1	Cloudy.	Smooth.	4½ ,,	29·68	4
7.40 a.m.	S.W.	41·18	49·9	48·2	35	,,	1	Overcast, fine rain.	,,	5¼ ,,	29·70	4
				51·6	17½							
Oct. 24.												
11.33 a.m.	N.E.	51·26	51·0	51·0	13	..	..	Fine.	Quite smooth.	2¼ ,,	30·28	7½
1.20 p.m.	S.W.	53·60	51·0	50·0	35	W.S.W.	2	Fine, cl'dy,	Smooth.	4h. 5m. fl.	30·29	6
				51·2	17½							
Nov. 28.												
9.15 a.m.	N.E.	50·72	49·2	50·0	15	W.	7	Showery.	Slight.	1¼ h. ebb.	30·18	1½
11.0 a.m.	S.W.	50·18	49·9	50·4	37	W.S.W.	7	,,	,,	3 ,,	30·19	1½
				50·0	18½							
Dec. 21.												
7.55 a.m.	N.E	41·54	46·2	50 0	14	N.E.	4	Cloudy.	Ripple.	5½ ,,	30·28	3
9.27 a.m.	S.W.	41·90	45·0	50·5	36	E.N.E.	4	,,	,,	1 h. fl.	,,	5
				49·4	18							

TABLE D.—SHOWING THE QUANTITIES OF FISH CAUGHT BY LINE IN 1899 WITHIN THE MORAY FIRTH (INSIDE A LINE BETWEEN DUNCANSBY HEAD AND RATTRAY POINT), AND THE NUMBER OF SHOTS OF THE BOATS BY WHICH THE FISH WERE CAUGHT.

WICK DISTRICT.

Months.	Number of Shots.		Cod.		Ling.		Torsk (Tusk).		Saithe (Coalfish).		Haddock.		Whiting.		Turbot.		Halibut.		Sole (Lemon Sole).		Flounder, Plaice, Brill.		Eel.		Skate.		Other kinds of White Fish.		Total of Line-caught Fish.	
	Large Boats.	Small Boats.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.
Jan.	549	509	3,315	3·133	284	0·268	13	0·012	2,219	2·097	133	0·125	.	.	24	0·022	99	0·093	.	.	.	.	92	0·087	535	0·5	102	0·096	6,816	6·442
Feb.	335	307	3,152	4·9	433	0·674	.	.	583	0·9	24	0·037	.	.	13	0·02	112	0·174	.	.	39	0·06	67	0·104	678	1·056	58	0·09	5,159	8·035
March	252	272	2,297	4·383	378	0·721	51	0·097	320	0·61	86	0·164	.	.	18	0·034	132	0·251	.	.	52	0·099	75	0·143	675	1·288	83	0·158	4,167	7·952
April	78	318	718	1·813	140	0·353	2	0·005	206	0·52	88	0·222	.	.	4	0·01	43	0·108	3	0·007	16	0·04	5	0·012	149	0·376	49	0·123	1,423	3·593
May	26	186	513	2·42	24	0·113	.	.	339	1·599	18	0·084	.	.	.	.	3	0·014	.	.	44	0·207	.	.	7	0·033	20	0·094	9 8	4·565
June	120	173	587	2·003	22	0·075	.	.	618	2·109	13	0·044	.	.	.	.	.	.	.	.	14	0·047	.	.	4	0·013	32	0·109	1,290	4·402
July	200	39	807	3·376	.	.	.	.	533	2·23	63	0·263	.	.	.	.	.	.	.	.	.	.	.	.	.	.	26	0·108	1,429	5·979
Aug.	300	234	1,276	2·389	.	.	.	.	984	1·842	48	0·09	.	.	.	.	.	.	.	.	25	0·046	.	.	.	.	68	0·127	2,401	4·496
Sept.	.	425	385	0·905	2	0·004	.	.	201	0·472	46	0·108	.	.	.	.	.	.	.	.	27	0·063	.	.	.	.	49	0·115	710	1·67
Oct.	.	477	404	0·846	.	.	.	.	155	0·324	42	0·088	.	.	.	.	.	.	.	.	23	0·048	.	.	.	.	57	0·119	681	1·427
Nov.	4	175	377	2·106	8	0·044	.	.	42	0·234	106	0·592	.	.	.	.	4	0·022	.	.	2	0·011	17	0·094	6	0·033	45	0·251	607	3·391
Dec.	1	134	253	1·874	2	0·014	.	.	130	0·963	39	0·288	.	.	1	0·007	1	0·007	2	0·014	12	0·088	5	0·037	7	0·051	13	0·096	465	3·444
Totals,	1,865	3,249	14,084	2·754	1,293	0·252	66	0·012	6,330	1·237	706	0·138	.	.	60	0·011	394	0·077	5	0·0009	234	0·049	261	0·051	2,061	0·403	602	0·117	26,116	5·106

TABLE D.—*continued.*—LYBSTER DISTRICT.

Months.	Number of Shots.		Cod.		Ling.		Torsk (Tusk).		Saithe (Coalfish).		Haddock.		Whiting.		Turbot.		Halibut		Sole (Lemon Sole).		Flounder, Plaice, Brill.		Eel.		Skate.		Other kinds of White Fish.		Total of Line-caught Fish.	
	Large Boats.	Small Boats.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.
Jan.	108	220	706	2·152	.	.	.	.	57	0·173	209	0·637	.	.	.	.	.	.	.	.	.	.	.	.	.	.	58	0·176	1,030	3·14
Feb.	90	120	840	4·0	.	.	.	.	46	0·219	103	0·49	.	.	.	.	6	0·028	.	.	.	.	11	0·052	.	.	80	0·38	1,086	5·171
March	18	106	192	1·548	.	.	.	.	.	.	17	0·137	.	.	.	.	1	0·008	.	.	.	.	.	.	.	.	14	0·112	224	1·806
April	.	90	110	1·222	.	.	.	.	.	.	8	0·088	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	0·044	122	1·355
May	.	147	139	0·945	.	.	.	.	29	0·197	13	0·088	.	.	.	.	.	.	.	.	.	.	.	.	.	.	17	0·115	198	1·346
June	29	116	154	1·062	.	.	.	.	34	0·234	5	0·034	.	.	.	.	.	.	.	.	.	.	.	.	.	.	22	0·151	215	1·482
July	652	39	145	0·21	.	.	.	.	83	0·12	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	30	0·043	258	0·373
Aug.	1,008	37	114	0·109	.	.	.	.	57	0·054	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	49	0·046	220	0·21
Sept.	23	76	111	1·121	.	.	.	.	30	0·303	6	0·06	.	.	.	.	.	.	.	.	.	.	37	0·373	.	.	25	0·252	209	2·111
Oct.	.	105	102	0·971	.	.	.	.	15	0·142	160	1·523	.	.	.	.	.	.	.	.	.	.	.	.	.	.	46	0·438	323	3·076
Nov.	.	73	69	0·945	.	.	.	.	13	0·178	182	2·493	.	.	.	.	.	.	.	.	.	.	.	.	.	.	25	0·342	289	3·958
Dec.	4	20	55	2·291	.	.	.	.	.	.	65	2·708	.	.	.	.	.	.	.	.	.	.	.	.	.	.	15	0·625	135	5·625
Totals,	1,932	1,149	2,737	0·888	.	.	.	.	364	0·118	768	0·249	.	.	.	.	7	0·002	.	.	.	.	48	0·015	.	.	385	0·124	4,309	1·398

TABLE D.—*continued.*—HELMSDALE DISTRICT.

Months.	Number of Shots.		Cod.		Ling.		Torsk (Tusk).		Saithe (Coalfish).		Haddock.		Whiting.		Turbot.		Halibut.		Sole (Lemon Sole).		Flounder, Plaice, Brill.		Eel.		Skate.		Other kinds of White Fish.		Total of Line-caught Fish.	
	Large Boats.	Small Boats.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.
Jan.	140	360	1,479	2·958	12	0·024	.	.	90	0·18	654	1·308	11	0·022	.	.	6	0·012	.	.	59	0·118	19	0·038	18	0·036	109	0·218	2,457	4·914
Feb.	133	361	1,492	3·02	13	0·026	.	.	23	0·046	218	0·441	2	0·004	.	.	6	0·012	.	.	453	0·917	12	0·024	9	0·018	33	0·066	2,261	4·576
March	109	193	695	2·301	.	.	.	.	19	0·062	32	0·106	2	0·006	.	.	4	0·013	.	.	223	0·738	2	0·006	6	0·019	.	.	983	3·255
April	.	166	147	0·885	.	.	.	.	20	0·12	21	0·126	.	.	.	.	.	.	.	.	66	0·397	.	.	.	.	50	0·301	304	1·831
May	.	220	185	0·84	.	.	.	.	44	0·2	56	0·254	.	.	.	.	.	.	.	.	56	0·254	.	.	.	.	65	0·295	406	1 845
June	.	198	130	0·656	.	.	.	.	56	0·282	56	0·282	.	.	.	.	.	.	.	.	13	0·065	.	.	.	.	40	0·202	295	1·49
July	.	51	49	0·96	.	.	.	.	28	0·55	38	0·745	.	.	.	.	.	.	.	.	30	0·588	33	0·647	.	.	15	0·294	193	3·784
Aug.	.	53	93	1·754	.	.	.	.	48	0·905	117	2·207	8	0·15	.	.	.	.	.	.	24	0·452	.	.	.	.	.	.	290	5·471
Sept.	.	323	193	0·597	.	.	.	.	26	0·08	814	2·613	13	0·04	.	.	.	.	.	.	197	0·609	21	0·065	.	.	.	.	1,294	4·006
Oct.	.	523	320	0·611	.	.	.	.	10	0·019	1,429	2·732	18	0·034	.	.	.	.	.	.	150	0·286	150	0·286	.	.	.	.	2,077	3·971
Nov.	.	327	303	0·926	10	0 03	.	.	13	0 04	987	3·018	12	0·036	.	.	.	.	.	.	21	0·064	30	0·091	9	0·027	62	0·189	1,447	4·425
Dec.	.	155	135	0·87	.	.	.	.	.	.	583	3·761	.	.	.	.	.	.	.	.	.	.	4	0·025	.	.	23	0·148	745	4·806
Totals,	382	2,930	5,221	1·576	35	0·01	.	.	377	0·113	5,035	1·52	66	0·019	.	.	16	0·004	.	.	1,292	0·39	271	0·081	42	0·012	397	0·119	12,752	3·85

TABLE D.—*continued.*—CROMARTY DISTRICT.

Months.	Number of Shots.		Cod.		Ling.		Torsk (Tusk).		Saithe (Coalfish).		Haddock.		Whiting.		Turbot.		Halibut.		Sole (Lemon Sole).		Flounder, Plaice, Brill.		Eel.		Skate.		Other kinds of White Fish.		Total of Line-caught Fish.	
	Large Boats.	Small Boats.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.
	.	655	459	0·7	.	.	.	.	14	0·021	706	1·077	4	0·006	.	.	1	0·001	.	.	.	.	.	.	2	0·003	37	0·056	1,223	1·867
Feb.	.	837	445	0·531	.	.	.	.	6	0·007	553	0·66	.	.	.	.	.	.	.	.	349	0·416	.	.	2	0·002	115	0·137	1,470	1·756
March	.	609	297	0·487	.	.	.	.	9	0·014	353	0·579	2	0·003	.	.	.	.	.	.	247	0·405	.	.	8	0·013	14	0·023	930	1·527
April	.	356	209	0·587	.	.	.	.	3	0·008	314	0·882	3	0·008	.	.	.	.	.	.	29	0·081	.	.	14	0·039	93	0·261	665	1·868
May	.	509	498	0·801	.	.	.	.	35	0·068	332	0·652	4	0·007	.	.	.	.	.	.	90	0·176	.	.	53	0·104	75	0·147	997	1·958
June	.	575	299	0·52	.	.	.	.	.	.	304	0·528	2	0·003	.	.	½	.	.	.	108	0·187	.	.	14	0·024	45	0·078	772½	1·343
July	2	144	47	0·321	.	.	.	.	9	0·061	192	1·315	5	0·034	.	.	.	.	.	.	43	0·294	.	.	6	0·041	16	0·109	318	2·178
Aug.	59	150	44	0·21	.	.	.	.	.	.	218	1·043	3	0·014	.	.	.	.	.	.	64	0·306	.	.	.	.	43	0·205	372	1·779
Sept.	.	525	108	0·205	.	.	.	.	.	.	673	1·281	2	0·003	.	.	.	.	.	.	104	0·198	.	.	.	.	51	0·097	938	1·786
Oct.	.	689	226	0·328	.	.	.	.	.	.	902	1·439	8	0·011	.	.	.	.	.	.	87	0·126	.	.	.	.	78	0·113	1,391	2·018
Nov.	.	483	234	0·484	.	.	.	.	.	.	603	1·248	9	0·018	.	.	.	.	.	.	11	0·022	.	.	.	.	75	0·155	932	1·929
Dec.	.	614	444	0·723	2	.	.	.	16	0·026	693	1·128	10	0·016	.	.	.	.	.	.	9	0·014	.	.	.	.	84	0·136	1,258	2·048
Totals,	61	6,146	3,220	0·518	2	.	.	.	92	0·014	5,811	0·95	52	.	.	.	1½	0·002	.	.	1,180	0·183	.	.	99	0·015	726	0·116	11,183	1·815

TABLE D.—*continued.*—FINDHORN DISTRICT.

Months.	Number of Shots.		Cod.		Ling.		Torsk (Tusk).		Saithe (Coalfish).		Haddock.		Whiting.		Turbot.		Halibut.		Sole (Lemon Sole).		Flounder, Plaice, Brill.		Eel.		Skate.		Other kinds of White Fish.		Total of Line-caught Fish.	
	Large Boats.	Small Boats.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.
Jan.	428	1,232	2,232	1·344	48	0·028	.	.	134	0·08	2,310	1·391	3	0·001	.	.	17	0·01	.	.	9	0·005	25	0·015	66	0·039	19	0·011	4,863	2·929
Feb.	384	1,126	2,536	1·679	44	0·029	.	.	64	0·42	1,753	1·16	3	0·002	.	.	14	0·009	.	.	399	0·264	7	0·004	36	0·023	15	0·009	4,871	3·225
March	752	629	3,139	2·273	47	0·034	.	.	41	0·029	1,038	0·751	4	0·002	.	.	23	0·016	.	.	405	0·293	2	0·001	101	0·073	8	0·005	4,808	3·481
April	158	568	592	0·815	56	0·077	.	.	42	0·057	461	0·635	.	.	.	.	15	0·02	.	.	214	0·294	.	.	73	0·1	10	0·013	1,463	2·015
May	25	720	270	0·362	39	0·052	.	.	72	0·096	685	0·919	13	0·017	.	.	6	0·008	.	.	87	0·117	.	.	21	0·028	12	0·016	1,205	1·617
June	20	771	87	0·109	.	.	.	.	4	0·005	898	1·135	33	0·041	.	.	.	.	.	.	39	0·049	.	.	.	.	9	0·011	1,070	1·352
July	1,219	492	30	0·017	.	.	.	.	12	0·007	447	0·261	83	0·048	.	.	.	.	.	.	62	0·036	.	.	.	.	4	0·002	638	0·372
Aug.	1,976	557	12	0·004	.	.	.	.	.	.	1,038	0·409	131	0·051	.	.	.	.	.	.	22	0·008	.	.	.	.	3	0·001	1,206	0·476
Sept.	72	937	104	0·103	.	.	.	.	.	.	1,804	1·787	71	0·07	.	.	.	.	.	.	210	0·208	.	.	.	.	5	0·005	2,194	2·174
Oct.	119	1,559	223	0·132	.	.	.	.	46	0·027	3,502	2·087	20	0·012	.	.	.	.	.	.	347	0·206	.	.	.	.	12	0·007	4,150	2·473
Nov.	117	1,324	281	0·195	.	.	.	.	29	0·02	2,349	1·63	16	0·011	.	.	.	.	.	.	172	0·119	.	.	.	.	6	0·004	2,853	1·979
Dec.	107	968	433	0·402	.	.	.	.	7	0·006	2,015	1·874	14	0·013	.	.	.	.	.	.	32	0·029	.	.	.	.	3	0·002	2,504	2·329
Totals,	5,377	10,883	9,939	0·611	234	0·014	.	.	451	0·027	18,300	1·125	391	0·024	.	.	75	0·004	.	.	1,998	0·122	34	0·002	297	0·018	106	0·006	31,825	1·957

TABLE D.—*continued.*—BUCKIE DISTRICT.

Months.	Number of Shots.		Cod.		Ling.		Torsk (Tusk).		Saithe (Coalfish).		Haddock.		Whiting.		Turbot.		Halibut.		Sole (Lemon Sole).		Flounder, Plaice, Brill.		Eel.		Skate.		Other kinds of White Fish.		Total of Line-caught Fish.	
	Large Boats.	Small Boats.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average
Jan.	544	1,085	3,031	1·86	264	0·162	3	0·001	300	0·184	3,737	2·294	.	.	.	.	48	0·029	.	.	.	.	29	0·017	240	0·147	18	0·011	7,670	4·708
Feb.	446	865	2,682	2·045	86	0·065	.	.	132	0·1	2,685	2·048	.	.	.	.	41	0·031	.	.		0·003	2	0·001	150	0·114	.	.	5,783	4·411
March	569	267	3,019	3·611	97	0·116	5	0·006	173	0·207	758	0·906	.	.	.	.	39	0·046	.	.	6	0·007	16	0·019	269	0·321	79	0·094	4,461	5·336
April	53	614	905	1·356	92	0·137	8	0·012	37	0·055	376	0·563	.	.	.	.	42	0·062	.	.	.	.	.	.	103	0·154	23	0·034	1,586	2·377
May	1	1,212	605	0·498	32	0·026	.	.	23	0·019	1,189	0·98	.	.	.	.	4	0·003	.	.	.	.	.	.	9	0·007	.	.	1,862	1·535
June	.	524	297	0·566	.	.	.	.	222	0·423	364	0·694	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	883	1·685
July	.	271	28	0·103	.	.	.	.	24	0·088	181	0·668	14	0·051	.	.	.	.	.	.	.	.	7	0·025	.	.	.	.	254	0·937
Aug.	.	174	18	0·103	.	.	.	.	.	.	302	1·735	51	0·293	.	.	.	.	.	.	6	0·034	15	0·086	.	.	.	.	392	2·252
Sept.	10	316	163	0·5	.	.	.	.	.	.	1,247	3·825	4	0·012	.	.	.	.	.	.	10	0·03	.	.	.	.	.	.	1,424	4·368
Oct.	74	1,259	533	0·399	.	.	.	.	.	.	3,860	2·895	3	0·002	.	.	.	.	.	.	18	0·013	.	.	.	.	.	.	4,414	3·311
Nov.	124	983	375	0·338	.	.	.	.	.	.	2,839	2·564	.	.	.	.	.	.	.	.	.	.	2	0·001	6	0·005	.	.	3,222	2·91
Dec.	119	906	1,008	0·983	.	.	.	.	.	.	1,967	1·919	7	0·006	.	.	.	.	.	.	.	.	10	0·009	19	0·018	12	0·011	3,023	2·949
Totals,	1,940	8,476	12,584	1·215	571	0·054	16	0·001	919	0·087	19,518	1·872	79	0·007	.	.	174	0·016	.	.	45	0·004	81	0·007	796	0·076	132	0·012	34,915	3·357

TABLE D.—*continued.*—BANFF DISTRICT.

Months.	Number of Shots.		Cod.		Ling.		Torsk (Tusk).		Saithe (Coalfish).		Haddock.		Whiting.		Turbot.		Halibut.		Sole (Lemon Sole).		Flounder, Plaice, Brill.		Eel.		Skate.		Other kinds of White Fish.		Total of Line-caught Fish.	
	Large Boats.	Small Boats.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.
Jan.	232	1,058	1,419	1·1	436	0·338	.	.	48	0·037	1,187	0·92	36	0·027	.	.	40	0·031	.	.	22	0·017	21	0·016	150	0·116	98	0·076	3,457	2·68
Feb.	268	1,347	766	0·474	179	0·110	.	.	29	0·017	1,793	1·110	20	0·012	.	.	33	0·02	.	.	12	0·007	8	0·004	75	0·046	104	0·064	3,019	1·869
March	234	755	444	0·448	56	0·056	.	.	25	0·025	1,080	1·092	6	0·006	.	.	12	0·012	1	0·001	11	0·011	4	0·004	18	0·018	39	0·039	1,696	1·714
April	78	520	135	0·225	2	0·003	.	.	38	0·063	584	0·976	6	0·01	.	.	.	.	.	.	12	0·02	.	.	.	.	43	0·071	820	1·371
May	.	272	84	0·308	25	0·091	.	.	229	0·842	460	1·691	27	0·099	.	.	10	0·036	.	.	5	0·018	.	.	8	0·029	23	0·084	871	3·202
June	.	257	82	0·319	5	0·019	.	.	403	1·568	270	1·05	31	0·120	.	.	.	.	.	.	4	0·015	.	.	.	.	17	0·066	812	3·159
July	.	198	15	0·075	2	0·01	.	.	63	0·318	346	1·747	31	0·156	.	.	.	.	.	.	2	0·01	.	.	.	.	5	0·025	464	2·343
Aug.	.	266	10	0·037	2	0·007	.	.	15	0·056	683	2·567	96	0·361	.	.	.	.	.	.	7	0·026	.	.	.	.	20	0·075	833	3·131
Sept.	13	989	265	0·264	.	.	.	.	.	.	3,091	3·084	119	0·118	.	.	.	.	.	.	17	0·016	.	.	.	.	119	0·118	3,611	3·603
Oct.	57	1,651	582	0·340	5	0·002	.	.	.	.	4,087	2·392	158	0·092	.	.	.	.	.	.	36	0·021	.	.	.	.	103	0·06	4,971	2·91
Nov.	100	1,306	461	0·327	5	0·003	.	.	.	.	2,269	1·613	94	0·066	.	.	.	.	.	.	74	0·052	2	0·001	5	0·003	96	0·068	3,006	2·138
Dec.	126	1,356	705	0·475	31	0·021	.	.	.	.	2,089	1·409	111	0·074	.	.	.	.	.	.	34	0·022	11	0·007	33	0·022	101	0·068	3,115	2·101
Totals,	1,108	9,975	4,968	0·448	748	0·067	.	.	850	0·076	17,939	1·618	735	0·066	.	.	95	0·008	1	0·00009	236	0·021	46	0·004	289	0·026	768	0·069	26,675	2·406

TABLE E.—Total Quantities of Fish caught by Line in 1899 within the Moray Firth (inside a Line between Duncansby Head and Rattray Point), and the Number of Shots of the Boats by which the Fish were caught.

Districts.	Number of Shots.		Cod.		Ling.		Torsk (Tusk).		Saithe (Coalfish).		Haddock.		Whiting.		Turbot.		Halibut.		Sole (Lemon Sole).		Flounder, Plaice, Brill.		Conger Eel.		Skate.		Other kinds of White Fish.		Total of Line-caught Fish.	
	Large Boats.	Small Boats.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.
Wick, .	1,865	3,249	14,084	2·754	1,293	0·252	66	0·012	6,330	1·237	706	0·138	.	.	60	0·011	394	0·077	5	0·0009	254	0·049	261	0·051	2,061	0·403	602	0·117	26,116	5·106
Lybster,	1,932	1,149	2,737	0·888	.	.	.	.	364	0·118	768	0·249	.	.	.	.	7	0·002	.	.	.	.	48	0·015	.	.	385	0·124	4,309	1·398
Helmsdale,	382	2,930	5,221	1·576	35	0·01	.	.	377	0·113	5,035	1·52	66	0·019	.	.	16	0·004	.	.	1,292	0·39	271	0·081	42	0·012	397	0·119	12,752	3·85
Cromarty,	61	6,146	3,220	0·518	2	0·0003	.	.	92	0·014	5,811	0·955	52	0·008	.	.	1½	0·0002	.	.	1,180	0·183	.	.	99	0·015	726	0·116	11,183	1·815
Findhorn,	5,377	10,883	9,939	0·611	234	0·014	.	.	451	0·027	18,300	1·125	391	0·024	.	.	75	0·004	.	.	1,998	0·122	34	0·002	297	0·018	106	0·006	31,825	1·957
Buckie,	1,940	8,476	12,584	1·21	571	0·054	16	0·001	919	0·087	19,518	1·872	79	0·007	.	.	174	0·016	.	.	45	0·004	81	0·007	796	0·076	132	0·012	34,915	3·357
Banff, .	1,108	9,975	4,968	0·448	748	0·067	.	.	850	0·076	17,939	1·618	735	0·066	.	.	95	0·008	1	0·00009	236	0·021	46	0·004	289	0·026	768	0·069	26,675	2·406
Totals,	12,665	42,808	52,753	0·952	2,883	0·052	82	0·001	9,383	0·169	68,075	1·229	1,323	0·023	60	0·001	762½	0·013	6	0·0001	5,005	0·089	741	0·013	3,584	0·064	3,116	0·056	147,775	2·666

II.—CONTRIBUTIONS TO THE LIFE-HISTORY OF THE EDIBLE CRAB (*Cancer pagurus*, Linn.).

By H. Chas. Williamson, M.A., B.Sc. (Plates I.-IV.).

CONTENTS.

	PAGE.
Introduction,	77
Size of Crab at Maturity :—	
The Mature Female Crab,	79
Fertilisation,	82
Annual Spawning,	85
Times of Spawning and Hatching,	88
Number of Eggs of Berried Crab,	89
The Mature Male Crab,	97
External Sexual Characters,	98
Proportional Numbers of the Sexes,	99
Exuviation, Casting,	104
The Occurrence of Soft Crabs: Hardening of Shell,	105
Frequency of Casting: Increase in size,	109
Regeneration of Lost Limbs: the Repair of Injuries,	111
Rate of Growth and Distribution,	113
The Migrations of Crabs: Labelling Experiment,	119
The Regulation of the Crab Fishery,	134

The edible crab (*Cancer pagurus*, Linn.) is to be found on all the coasts of Great Britain and Ireland. It gives rise to important fisheries, the chief of which are in the English Channel, and on the east coasts of England and Scotland. Owing to the fact that the crab is found close to the shore, the fishery may be carried on with small boats. In 1877, as a result of the report of the Crab and Lobster Commission of 1876-7 the Fisheries (Oyster, Crab, and Lobster) Act was passed. With a view to develop the fishery, and to check a tendency to deterioration which was evident in certain districts, the measure prohibited the sale of (1) any crab less than 4¼ inches across the broadest part of the back, (2) any soft crab, (3) any berried crab. The first and second classes of crabs are practically unsaleable; berried crabs are seldom captured. The law, however, made an exception in the use of crabs for bait; so that while small, soft, and berried crabs could not be sold, they might be broken up for bait. The result was that the law, so far as protection was aimed at, was to a considerable extent inoperative. In certain places crab fishing is carried on more or less for the greater part of the year; in some districts, however, during autumn, when a considerable proportion of the catch consists of unsaleable crabs, viz., soft, and when the price falls in consequence of the inferior quality of some of the saleable crabs, viz. those which have just become hard, the fishermen discontinue this for some other mode of fishing. In Dunbar, a port which may be said to have devoted itself specially to crab fishing, the fishery is pursued during the whole year, with, however, intervals, during which the majority of the men take up the summer and winter herring fishing. Within the past few years the crab fisheries of England have attracted a large amount of attention from the District Committees, which were created by the Sea Fisheries Regulation Acts, 1888-1894. The shortcomings of the Act of 1877 have been recognised,

and in various ways its provisions have been rendered more stringent by local bye-laws.* They have resulted in (1) an increase in the legal minimum size to 5 inches, in one district (Lancashire) to 6 inches; (2) the protection of small and soft crabs; (3) the institution of a close time, the main object of which is the protection of soft crabs. In the protection of crabs there is no difficulty such as is encountered in the case of fishes, where capture may result in serious injury. The crabs which may be protected by law can be returned to the sea uninjured.

As a necessary prelude to legislation, attention has been directed to the study of the life-history of the crab; and on this subject papers have been published by Wilson,† Meek,‡ and Cunningham.§ Much remains to be done, however, ere the life of this form and its relation to the industry can be regarded as fully known. Mr. W. E. Archer and Mr. H. M. Malan, H.M. Inspectors of Fisheries for England and Wales, in their report to the Board of Trade anent the proposal of the Northumberland Sea Fisheries Committee to institute a close season for crabs, said, *inter alia*:—"We think that if these considerations were pointed out to the Committee they might be moved to take steps to obtain more definite information respecting the life-histories of lobsters and crabs, which could not fail to be of the utmost importance, both to themselves and the country, on a question which at present gives rise to such conflicting opinions."

An important point is raised by the question whether or not an increase in the legal limit would tend to raise the average size of the crabs captured. On the East Coast the crabs are small; in Cornwall very large crabs are taken. The numbers of male crabs over 8 inches in breadth captured in the latter district is, as may be seen from Cunningham's report § (p. 20), considerable. The crabs caught at Dunbar do sometimes reach that size, one female, which came under my own observation, measuring $8\frac{3}{16}$ inches. Spence Bate‖ was of the opinion "that the small size of the crabs on the East Coast is due to the temperature; and that Cornwall, where the largest crabs are taken, is the central habitat of the species." This is a view which is probably open to question. It may in part be due to the fact that the crab fishing is more actively pursued on the East Coast than in Cornwall. The Commissioners of 1876 reported, with regard to the fishing in Cornwall (p. x.), "that storms constantly interfere with the calling of the fishermen, and the weather itself imposes a natural close season without the intervention of Parliament." There is no evidence that the crab fishing in Scotland is declining, though very great fluctuations in the total catch appear from year to year (*vide* Table, p. 134). From 1895–1898 the number of creels owned by the fishermen increased from 71,968 to 77,157. How far the increase in gear is accountable for the increased take is an open question.

The institution of a close season with the view of protecting the soft crabs is a remedy which in the present condition of the inshore line fishing would press hardly on the fishermen of certain localities. In Dunbar, for example, the boats, which are small and undecked, are unfitted for the active prosecution of the line fishing. The boats are

* The new regulations are summarised on p. 140.

† Wilson, Northumberland Sea Fisheries Committee, Reports on the Crab Fishery, 1893 and 1895. Newcastle-on-Tyne.

‡ Meek, Northumberland Sea Fisheries Committee, Reports on the Trawling Excursions, 1897, 1898, 1899. Newcastle-on-Tyne.

§ Cunningham, Cornwall County Council, Report of the Executive Committee for Fisheries, 1897-98. Penzance, 1898.

‖ Reports on the Crab and Lobster Fisheries of England and Wales, of Scotland, and of Ireland [C. 1695], 1877. England, p. 56.

open, since, if they were decked, they would not be suitable for the transport of the large fleet of creels.

The present research* has been carried on with the view of adding to the knowledge of the life-history of the crab, upon which legislative interference with the fishery ought to be principally, if not altogether, based. A number of new facts are brought to bear upon such important questions as the size at maturity, the seasonal migrations, distribution, the season of casting, and other points.

Size of Crab at Maturity.

The Mature Female Crab.

There are three characters by which a mature female may be recognised, viz. (1) its being berried, (2) the ripeness of the ovary, (3) the presence of sperms in the spermatheca.

The first character is one which can only be applied as a test of maturity in a comparatively small number of cases, owing to the fact that the berried crab, unlike the berried lobster, is rarely captured in the creels. Cunningham† considers that the reason for this most likely is "that the movements of the female crab are hindered by the mass of spawn much more than are the movements of berried lobsters." While this may be the case to some extent, it seems probable that the berried crab is forced to keep in shelter, in some crevice or hole, where it will not be exposed to the attacks of other crabs. When not berried the abdomen (or tail) is the least vulnerable part of the body, but when it carries the large mass of eggs it is kept extended from the body, and could then be easily torn off. The berried crabs kept in the tanks at Dunbar did not appear to move about much, for the food (pieces of fish) which was scattered over the bottom of the tank was often left untouched, while in the tanks which contained unberried crabs the food was always devoured during the night, a fact probably due to the reluctance of the former to leave their retreats, where they lay half buried in the sand. This, no doubt, accounts for their absence from the creels; their occasional capture may have resulted from the fact that the creel has fallen quite close to where they lay hid. There is evidence, however, that the berried female undertakes a journey from deep water to the shallows.

If, then, the berried condition were the only standard, we should have few data upon which to found our conclusions. But, fortunately, it is possible, for several months afterwards, to recognise a crab which has borne and hatched its eggs. As Spence Bate‡ pointed out, after the eggs hatch, the empty egg-capsules remain attached to the swimmerets for some time. He added that they were got rid of when the crab cast. They are, however, in many cases thrown off before casting. The main mass of empty egg-capsules is sloughed off shortly after the eggs hatch, but a few may be detected on the bases of the endopodites (viz., on the posterior surface of base of endopodite of 1st and inner surface of base of 4th swimmeret) in some cases five months after that period. We thus have a very useful distinguishing mark of a mature female, and,

* I beg to acknowledge my indebtedness to Mr. W. Hutchison, Dunbar, for much valuable assistance. During my absence from Dunbar he took charge of the labelling experiments, and of the different crab statistics kept at Dunbar in 1899.

† Report of the Executive Committee for Fisheries, Cornwall County Council, for 1897-1898. Penzance, 1898, p. 5.

‡ Reports of the Crab and Lobster Fisheries of England, Wales, and Scotland. Buckland, Walpole and Young [C. 1695], 1877, p. 56.

moreover, one which is capable of wide application, since these crabs are common in the creels.

Wilson* has given some attention to the question of the size of the crab at maturity. He says that it had been repeatedly stated that the berried crabs that are got in the creaves (creels) are larger than 6 inches. The smallest berried female of which he had heard was one which Mr. Buglass, fishery officer, said measured about 4½ inches, while the shell of another, 5 7/16 inches, was shown him by Mr. Story, fishery officer. The smallest crab which he observed with a ripening ovary was 5⅛ inches across the back; none other was less than 5½ inches. He sums up his conclusions as follows:—"After carefully examining many hundred crabs at all seasons, I am now convinced that the ordinary size of maturity of the female crabs of the Northumberland coast is above 6 inches. . . . A very small percentage are mature when under 6 inches; a considerable minority mature when between 6 and 6½ inches; and between 6½ and 7 inches the great majority are mature." Couch, in his "Cornish Fauna,"† says that the female crab begins to breed when the carapace is about 3 inches across. In his evidence, given before the Crab and Lobster Commission (p. 55), Mr. Roach, Plymouth, stated that he had once caught a berried crab 4 inches across, but that they are generally much larger.

The evidence which I have collected at Dunbar from the examination of berried crabs, and those having the empty egg-capsules still adhering to their swimmerets,‡ is given in the following Table; it does not bear out the conclusions arrived at by Wilson:—

SIZES OF MATURE CRABS (BERRIED CRABS AND CRABS WITH EMPTY EGG-CAPSULES).

Size. Ins.	Berried Crabs.	Crabs with Empty Egg-capsules	Total.	Size. Ins.	Berried Crabs.	Crabs with Empty Egg-capsules	Total.	Size. Ins.	Berried Crabs.	Crabs with Empty Egg-capsules	Total.	Size. Ins.	Berried Crabs.	Crabs with Empty Egg-capsules	Total.
4⅞	.	1	1	5⅛	4	3	7	6⅜	1	3	4	7¼	.	.	.
5	.	.	.	5⅜	5	2	7	6½	4	2	6	7½	.	.	.
5⅛	.	1	1	5½	1	2	3	6⅝	1	2	3	7⅜	.	.	.
5¼	.	3	3	6	3	1	4	6¾	3	3	6	7½	.	2	2
5⅜	2	2	4	6⅛	.	1	1	6⅞	2	.	2	7⅝	1	.	1
5½	1	1	2	6¼	3	3	6	7	1	1	2	7¾	.	.	.

BERRIED CRABS, 32; CRABS WITH EMPTY EGG-CAPSULES, 33. TOTAL, 65.

The smallest mature crab is one at 4⅞ inches. Of a total of 65 individuals, 28 were less than 6 inches across; 37 were over that size. The crabs here recorded were not selected with a view of determining the size of the smallest mature crab, and from evidence supplied by the presence of sperms in the spermatheca I have no doubt that a careful examination of small crabs would reveal a considerable number of mature individuals of less breadth than 5 inches. The crab is mature, however, at a much earlier stage than Wilson supposed. The figures are not sufficient to admit of any calculation of the proportions of

* Northumberland Sea-Fisheries Committee. Further Report on the Crab Fishery of Northumberland, Newcastle-on-Tyne, 1895, p. 6.

† Cf., 2nd edit., 1878, p. 63.

‡ Marked Eh. in Table II., p. 94.

mature crabs at the different sizes; further investigation is required ere this could be satisfactorily accomplished. While it is not impossible that the crabs on the Northumberland coast become mature at a later stage than those off Dunbar, I think it highly improbable. The conclusion, so far as the berried crabs and those with empty egg-capsules are concerned, then, is that the female crab may be mature at the size of $4\frac{7}{8}$ inches, and that a large proportion of the crabs are mature between 5 and 6 inches.

With regard to the second character, viz., the development of the ovary, it may be granted that when the ovary is ripe the crab will carry eggs before it casts; in other words, before it increases in size. Herrick,* however, has recorded two cases where the lobster had extruded its eggs immediately after casting. He regards such a process as extremely rare. The ovary must have been ripe at the time of casting. No analogous case in the crab has come under my observation. This contingency may, I think, be neglected; the presence of a ripening ovary may be regarded as a proof of maturity. Wilson,† from his examination of the ovaries, states that "nearly all the large and hard autumn crabs are ripe, or almost ripe; whereas, though, as I have found, crabs in a similar condition occur at other times of the year, they are proportionately few." In a ripe ovary all the eggs are not of one size. The diameter of the yolk mass may vary from ·3–·41mm.; in some eggs the yolk sphere is as small as ·24mm. The diameter of the *zona radiata* varies greatly from the fact that the egg in the ovary has a large perivitelline space. In the egg, when carried on the swimmerets, the perivitelline space is very slight. In the ovary the diameter of the capsule may vary from ·44–·7mm. The eggs are slightly oval. The external eggs measure—outer capsule, ·44 × ·41, ·45 × ·45, ·44 × ·46, ·51 × ·48; egg sphere, ·4 × ·4, ·38 × ·4, ·4 × ·38, ·42 × ·42. The ripe ovary is of a turkey-red colour. It is very much distended, and covers almost the whole dorsal surface of the body of the crab. It contains a large quantity of an amber-coloured fluid. I have not met with a ripe ovary in a crab at any other time than autumn and winter. The unripe ovary is of a pale colour, with often a slight greenish tinge. It contains small unyolked eggs on an average about ·1mm. in diameter. The eggs become yolked when about ·2mm. in diameter, and in consequence the ovary assumes an orange colour, at other times pink or red. Yolked eggs of ·2 and ·24mm. diameter are found also in white ovaries. The so-called coral condition of the ovary is not an indication of ripeness. In each month of the year, with the exception of March, April, and September, when I have not dissected any crab, I have found the ovary with yolked eggs, and consequently coloured either orange or red. An analysis of a number of crabs with respect to the condition of the ovary and the size of the eggs is given in the Table on p. 90. They are arranged in the months during which they were obtained and examined. The presence of a coloured ovary is, then, an indication of maturity. The developing ovary is very seldom found in a soft crab. A soft crab in August, measuring $5\frac{7}{8}$ inches had an orange-coloured ovary, with eggs of about ·15mm. That was the only case in which other than a pale white organ was found before the crab had become hard. While the number of hard crabs examined was large, they are not of sufficient diversity in size to afford much evidence on the question of the smallest

* "The American Lobster: a Study of its Habits and Development." *Bulletin U.S. Fish Commission* for 1895, p. 35.

† *Op. cit.*, p. 4.

size of maturity. The following crabs under 6 inches were found with ripening ovaries, viz. two crabs at 5 inches; two at $5\frac{1}{16}$ inches, one at each of the following sizes—$5\frac{1}{4}$, $5\frac{3}{8}$, $5\frac{1}{2}$, $5\frac{5}{8}$, $5\frac{7}{8}$; two at $5\frac{3}{4}$. In the smallest size we have a close agreement with the data afforded by the berried crabs and those with empty egg-capsules—viz., $4\frac{7}{8}$.

So far the term mature has been limited to those crabs which give proof that they have actually reproduced their species (berried) or are preparing to do so (ripening ovary). It is now necessary to include in the term mature those which are *capable* of reproducing their species. A female crab may be physiologically mature when of a certain size, and still its ovary may not ripen. The male crab does not, as in most forms, impregnate the eggs directly. It introduces its sperms into the spermatheca of the female immediately the latter casts its shell, and the sperms are retained in the specialised diverticulum of the vagina for probably in most cases about a year before they are used to impregnate the ova. It then follows that if a crab is not fertilised when it casts it cannot reproduce its species till the next cast. A crab measuring $4\frac{1}{8}$ inches across is capable of fertilisation, but many crabs measuring from $4\frac{1}{8}$ to $5\frac{3}{8}$ inches are not fertilised. The latter will not be functionally mature till they are of larger size. So far the evidence will not permit me to say that every crab at $4\frac{1}{8}$ inches is thus mature, nor is it quite certain that no crab smaller than that is mature. Of 54 crabs measuring $4\frac{1}{8}$–$5\frac{3}{8}$ inclusive, 29 were fertilised and 25 unfertilised. No fertilised crab was found among the 27 less than $4\frac{1}{8}$ inches across; and every crab above $5\frac{3}{8}$ inches, viz. 76 in number, was fertilised.

Fertilised and Unfertilised Female Crabs.

Analysis of 157 Female Crabs, measuring from 3–$8\frac{1}{8}$ inches.

Inches.	3–4	$4\frac{1}{8}$	$4\frac{3}{8}$	$4\frac{5}{8}$	$4\frac{7}{8}$	$5\frac{1}{8}$	$5\frac{3}{8}$	5	$5\frac{1}{8}$	$5\frac{3}{8}$	$5\frac{5}{8}$	$5\frac{7}{8}$–$8\frac{1}{8}$
Unfertilised .	27	4	5	.	3	2	3	3	2	1	2	.
Fertilised .	.	2	1	1	1	2	2	7	3	7	3	76

A female crab which is capable of being fertilised differs structurally from an actually immature specimen, in that the vagina of the former is of large diameter, and the spermatheca is a sac of considerable size; in the latter the vagina is narrow and the spermatheca is so small that it is with difficulty made out. The latter condition has been found in crabs $3\frac{1}{4}$, $3\frac{1}{2}$ (2), $3\frac{3}{4}$, (3) $4\frac{1}{16}$, $4\frac{1}{4}$ (2) inches. These crabs could not be fertilised because the vagina would not admit the penis of the male.

Fertilisation.

The male crab, it is very probable, only has connection with the female at the moment the latter casts its shell, and while the new shell is still pliable. The male copulatory organ is paired, as also are the vagina and spermatheca paired. Each penis consists of two elements—the anterior, which is tubular, situated on the first abdominal segment; the posterior, which is solid, rod-like, situated on the second abdominal segment (Plate I., fig. 8). The posterior element is received into the tube of the anterior. The penis is inserted into the spermatheca and the spermatophores are by it conveyed there. In the female the genital organs consist of two vulvæ, two vaginæ, and two spermathecæ. When the female casts, the inner lining of the vagina and spermatheca are shed with the old shell. At this time the glands of the spermatheca

are active and pour a profuse gelatinous secretion into the spermatheca. This fluid when treated with sea-water coagulates and turns white. After fertilisation has taken place the vagina is found to be plugged, a large white body effectually closing up the mouth of the spermatheca and the vagina.* This body is much constricted at the mouth of the spermatheca (fig. 6 *ib.*). It may be readily split longitudinally into two halves (fig. 3). It is, without doubt, formed from the secretion of the glands of the spermatheca. The fluid very probably flows out into the vagina when the penis is introduced, and on the withdrawal of the latter it solidifies and remains as a plug. This plug is to be seen in all soft female crabs which have been fertilised, with a few exceptions. Occasionally the plug is found in one vagina, while it is absent from the other. Two male crabs were found which had attached to their penes portions of the plug. In one case a crab $5\frac{1}{16}$, which was still soft when obtained in October, had one of the halves of a plug attached to the penis (fig. 8); while another, a crab of 5 inches, which had been labelled (No. 826), had in November what appeared to be a small portion of a plug on the base of the penis. The absence of the plug from the vagina of the female may thus be accounted for. The plugs remain some considerable time in the vagina, but disappear about the time the crab becomes hard. Occasionally traces of the head of the plug are apparently made out in the spermatheca. The vulva then closes, a condition which is effected by its muscular structure. Up till this time, and even later, the secretion remaining in the spermatheca has retained a fluid consistency; but it has nevertheless become more viscid, and of a deeper amber colour. It eventually solidifies completely, and the spermatheca shrinks. The mass of sperms, which shows very white through the wall of the spermatheca, lies close to the opening of the oviduct. Shortly after fertilization spermatophores are to be made out in the spermatheca along with independent sperms and fat-globules, which are evidently derived from the colourless fluid of the vas deferens. The capsule of the spermatophore seems to rupture soon after it reaches the spermatheca, for even before the crab has become hard the sperms are all found to be free. When the spermatheca shrinks, it contains the amber-coloured solid in its distal part (fig. 9 *ib.*), and just inside the mouth, at the opening of the oviduct, are massed the sperms. When the female extrudes her eggs, certain of the eggs are occasionally left behind in the spermatheca, and they are to be seen in the amber solid. In a female crab which has hatched its eggs, the solid substance in the spermatheca is usually of two distinct kinds. It is very probable that that is due to some of the ovarian fluid which is present at the time the ovary is ripe lodging in the spermatheca and there solidifying.

Cano,† in referring to Milne Edwards' observation of the white plug in the female edible crab, states that "it is no other than the remains of the secretion which serves to glue the eggs at the moment of their extrusion." Milne Edwards' supposition that the plug was the terminal portion of the membranous penis of the male is of course quite erroneous; but Cano is also at fault in his explanation.

It has been stated that the male crab after it has fertilized the soft female retires to shelter in order to cast. Cano‡ says that, "in Decapod Crustacea, coupling is always preceded by casting, first of the male, then

* Present also in *Carcinus mœnas.*

† Cano, "Morfologia dell' apparecchio sessuale femminile, glandole del cemento e fecondazione nei Crostacei Decapodi." *Mittheilungen aus der Zoologischen Station zu Neapel*, Bd. IX., p. 510 *Note*, 1889–1891.

‡ *Op. cit.*, p. 530.

of the female." Mr. Hutton,* Customs Officer, Peterhead, stated before the Crab and Lobster Commission that when the female becomes a "peelert," that is a soft crab, which she does yearly in the end of July, and in August and September, the male crab, which does not cast its shell at this time, mates."

The reason why some mature females are not fertilised is that when they cast no mature male had been present. A crab of, say, $4\frac{1}{4}$ inches had been before it cast probably $3\frac{1}{2}$ inches across. It was then in what may be called for convenience the $2\frac{1}{2}$–4 inches group. This group contains no mature females, but it contains a few mature males (*see* below). There is good reason for believing that the crabs will be found grouped according to size in defined areas of the sea bottom. It is not improbable that these are age groups. The habitat of the $2\frac{1}{2}$–4 inches group is not known, but it is believed to be just outside low-water mark. The crabs on casting out of the last immature group ($2\frac{1}{2}$–4 inches) enter the adult group, to which belong the crabs which are caught in the creels; the latter measure from below 4 inches up to 8 inches (*vide* Table IX. for sizes of creel crabs). In the adult group, owing to the fact that practically all the males are mature, the fertilisation of the female is almost certain; but when a female in the immature group casts, the chances of being fertilised by one of the few mature males are of course very much less. It is not improbable that all of the unfertilised females of $4\frac{1}{8}$–$5\frac{3}{8}$ inches had before casting belonged to the immature group. If this is so, a great variation in growth is apparent. It is probable that the capacity for fertilisation, or, in other words, the maturity of the crab, depends upon its age, not its size. The greatest variation appears in the growth of the crab, and a difference of even $1\frac{1}{4}$ inches in breadth is probably not infrequent between large individuals of the same age.

The crabs smaller than the adult group, *e.g.*, below $4\frac{1}{8}$ inches, cast at least once a year. This is apparent from the fact that, with very few exceptions, their shells are always clean. Any Ectozoa found upon them are small, *e.g.*, *Serpula*, *Spirorbis*, and Zoophytes. Only rarely do we find one of these small crabs with a large amount of Ectozoa. A male crab measuring $2\frac{3}{4}$ inches across, and which had a large *Sacculina* attached to its abdomen, was dirty, and appeared not to have cast for a year or two.‡ Another, $3\frac{3}{16}$ inches across, a female, was covered with large *Anomia*; on the swimmerets were a large *Saxicava* and an *Anomia*, which kept the abdomen away from the thorax. All the hairs of the third and fourth swimmerets were rubbed off. It appeared not to have cast for a considerable time, more than one year, previously. A third crab, a male, $3\frac{15}{16}$ inches, was very black and dirty. The liver was very small, and scattered through it were small black rod-like and large red spherical bodies.† These appeared to be encysted parasites. A female, $3\frac{5}{16}$ inches, had evidently not cast for some time, judging from the dirty condition of the shell. Casting among the immature crabs, then, appears to be inhibited by parasites, which interfere with the nourishment of the creature. In the mature group reproduction inhibits casting, and for an analogous reason, namely, the employment, for the development of the sexual organs, of the nourishment which would otherwise have been used up in the growth of the crab. The crabs over $4\frac{1}{8}$ inches which are capable of reproduction, but which have not been fertilised, are to all intents and

* Report of the Crab and Lobster Commission, 1877. Evidence for Scotland, p. 12.

† *Vide* Cuénot, "Études physiologiques sur les Crustacés décapodes," *Archives de Biologie*, T. xiii., 1895.

‡ It is well known that crabs infested by *Sacculina* do not moult. (Cf. Delage, "Évolution de la Sacculine," *Arch. Zool. Expér.* (2), II., 1884, p. 666.

purposes still immature. They will therefore probably cast again the next year. In those crabs which are fertilised the ovaries will develop, in response to the stimulus supplied by the presence of the sperms in the spermatheca. As to how long an interval elapses between casting and the extrusion of the eggs my evidence is not complete. But, while a large number of the crabs will not become berried until at least about 12 months after they have cast, still there is a certain amount of evidence that a crab may extrude its eggs in the winter immediately following the summer when it cast. A number of soft crabs were kept in confinement at Dunbar from September 25th till early in December. They were, with the exception of one ($5\frac{3}{8}$ inches), over $5\frac{1}{2}$ inches in breadth. Two of these crabs, $5\frac{7}{8}$ and $7\frac{1}{8}$ inches, were on 9th December not quite hard; the former had a white ovary with yolked eggs measuring ·2mm. in diameter; in the latter the ovary was orange-coloured and contained eggs ·2 and ·24mm. Certain crabs which are hard, of clean appearance, and white on the under surface, are known as "China crabs"; they are got towards the end of the year, and are, without doubt, crabs which have cast during the summer. One of these examined in December was $5\frac{15}{16}$ inches across, and had a scarlet ovary with eggs ·35mm., that is to say, very near, if not quite, ripe, and certainly as large as many of the eggs in a ripe ovary. Another of the same, measuring $6\frac{7}{16}$, showed a pink ovary, with eggs ·15 and ·24mm. in diameter. Many of the casters of one year are certainly not berried until the winter of the following year. During the summer following the cast they are found to be clean and light-coloured, and with coloured developing ovaries, which will be ripe in the succeeding October. Several of these clean crabs were obtained in May and others in July. They were placed in the tanks at Dunbar, and of the survivors one was berried in November; another was ripe in December, but was killed before it extruded its eggs; a third had yolked eggs ·24 and ·27mm. in diameter; and a fourth, killed in February, was ripe. (*Vide* Table, pp. 92, 93.) The conditions of captivity were probably not very favourable for spawning; but, in any case, it is the fact that many of the female crabs of mature size, which cast in any year, are hard, full crabs, with ripening ovaries in the following summer, and extrude their eggs in the winter; that is to say, about 14 months after casting. Those crabs which cast early in the year—in July, for example—would be more likely, then, to have ripe ovaries at the end of the year than those which cast in September. If now, for clearness, we give an age to the crab of the mature group, expressed in a number of months counted from its cast, we may conclude that certain crabs may be berried in six months, while others are not berried until over twelve months afterwards.

Annual Spawning.

A crab does not always cast immediately it hatches its eggs. It very often carries eggs two years in succession. The supply of sperms which it receives when soft is not all used up in fertilising the first batch of eggs, and so long as the sperms are present in the spermatheca the crabs will probably not cast. In fact, everything points to the probability of the crab usually carrying two batches at least before it casts again. This is demonstrated by an examination of those crabs which are berried and those which have recently hatched their eggs. The particulars of a number of these crabs will be found in Table II., p. 94. The ovary of a berried crab just after it has extruded its eggs is small and pale in colour, a slight greenish tinge being, however, sometimes noticed. The eggs are small, transparent, non-yolked, about ·1mm. in

diameter. Here and there through the ovary appear ripe eggs which have not been extruded with the main mass. In May and July, in three examples dissected, yolked eggs were found; two of the ovaries were white, the third red. In the crabs which have just hatched their eggs the ovaries were found to be of a red colour. (Table II., p. 94, July.) In August seven examples came under observation; they, with one exception, showed developing ovaries and varying quantities of sperms in the spermatheca. In October and December 1899, of the nineteen dissected crabs which showed by the presence of the empty egg-capsules on their swimmerets that they had hatched their eggs during the summer immediately preceding, many had ripe eggs. A number of crabs which had hatched their eggs in the tanks at Dunbar were kept there until November. One measuring $5\frac{5}{8}$ inches across had an orange ovary. Four which survived till December had ovaries pink or orange in colour, and containing eggs measuring from ·15–·27mm. in diameter. On December 1st a female measuring $5\frac{1}{4}$ inches across was found to have a few empty egg-capsules on the base of the swimmerets. On December 9th it extruded a quantity of eggs. A berried crab, 6 inches across, which was got from Dunbar on December 9th, 1899, was examined on its death in February. Empty egg-capsules were found at the base of the endopodite of the fourth swimmeret. They were to some extent concealed by the mass of the new eggs which was attached to the limb. The actual proof supplied by the last two crabs—that the female may carry eggs in two successive years—is led up to by the evidence afforded by the condition of the ovaries of the crabs which had lately been berried. We have, then, in the female crab, reproductive periods of two years at least, separated by growth (or casting) intervals. Those crabs which are not preparing to carry another batch of eggs appear to cast very soon after the brood hatches; but it is not improbable that some do not cast till the following summer. A certain amount of evidence bearing upon this question in the lobster has been published. Herrick* writes as follows:—"Females usually moult shortly after the hatching of a brood." Of several lobsters which had hatched their eggs, and which were placed in confinement by Cunningham† in September, two cast their shells—one on November 27th and the other about February 9th. Meek‡ records a female lobster which was brought to Cullercoats Laboratory, "evidently after hatching; she cast her shell in the tank during 17–18th August."

With regard to the frequency of spawning in the lobster, there has been considerable divergence of opinion. Thus, Ehrenbaum§ was of the opinion that the European lobster becomes productive only once in four years. Fullarton‖ considered that the lobster did not spawn two years in succession. Herrick¶ accepts the position of Garman, viz., "that the female lobster lays eggs but once in two years, the laying periods being two years apart." Herrick found immature ovaries in 21 lobsters which had recently hatched their eggs, and concludes—"That the spawning periods are thus two years apart is a valid inference drawn from the study of the reproductive organs" (p. 71). Allen** in this connection says—"An examination made at the end of July of the ovary

* *Op. cit.*, p. 35.

† *Op. cit.*, pp. 40, 41.

‡ Northumberland Sea Fisheries Committee. "Report on the Trawling Excursions, &c," 1899, p. 54.

§ "Der Helgolander Hummer," *Wissenschaftliche Meeresuntersuchungen*, Neue Folge, 1 Bd., Hft. 1, Kiel, 1894.

‖ *Fourteenth Annual Report of the Fishery Board*, Part III., p. 186.

¶ *Op. cit.*, p. 70.

** "The Reproduction of the Lobster," *Journal of the Marine Biological Association*, N. S., Vol IV., No 1, pp. 60-69.

of a female whose brood had just been hatched did not appear to me in itself to offer evidence for or against the view that eggs would not be laid during the summer. . . . If no further evidence of a different kind were forthcoming one would, I think, have been inclined to expect that the eggs would have been laid during the same summer." Prince* combated the theory of biennial spawning on histological and other grounds. In a footnote (p. 72) Herrick adds—"The best way to test the question by experiment would be to take a female which had recently hatched a brood, and keep her alive until the following summer, when the next batch of eggs would be due, in case the spawning period is a biennial one." This has been done by Cunningham,† and the result of the experiment has been to disprove the contention of Ehrenbaum, Herrick, and Fullarton. Of five lobsters which had hatched their eggs, and which were put into a floating box in September, one was berried on October 14th; another examined on February 9th evidently had a ripe ovary, but having apparently failed to extrude the eggs, the latter were being absorbed. Two of the remaining lobsters cast their shells; the fifth escaped from the box. These facts, then, point to the conclusion that, as in the case of the crab, the lobster may carry eggs two years in succession. The lobsters which Herrick dissected were probably about to cast, and when growth is taking place the ovaries would appear to be quiescent. The crab will not, I believe, prepare for casting so long as a supply of sperms remains in the spermatheca; in other words, it will keep on having successive batches of eggs until the supply of sperms is exhausted.‡ A crab on casting throws off the inner lining of the spermatheca and vagina in addition to its exoskeleton, and therefore the contents of the spermatheca are also discarded at that time. The presence or absence of sperms is what decides the direction in the former case of the nourishment to the ovary; in the latter to the general tissue, and especially the subdermal areolar tissue. This is, no doubt, what takes place generally; but the absence of sperms from the spermatheca does not in all cases prevent the development of the ovary. Thus, two crabs with empty egg-capsules, one $4\frac{7}{8}$ inches, got in October, and another $6\frac{11}{16}$ inches in December, had red ovaries which were practically ripe, although the spermatheca showed no sperms. Another $5\frac{5}{16}$ inches (October) had an orange-coloured ovary with eggs ·2mm. There was in respect to certain characters some evidence that these crabs were preparing to cast. Again, in one crab which was soft, mentioned above, an orange-coloured ovary, with small eggs however (·15mm.), was observed. Herrick mentions two cases of the lobster extruding its eggs shortly after casting. In such circumstances the ovaries must have been ripe before the casting. It is very probable the ripening of the ovary while the crab is preparing to cast may be due to the fact that the crab had had the advantage of a large food supply, and therefore had an excess of nutritive material, which was laid up in the ovary. In most cases it is, however, the case that the ovary at casting is little developed. The stage of development of the ovary at the time the crab casts will, no doubt, have the effect of shortening or lengthening the period between casting and spawning. Thus, if a crab has a ripe ovary when it casts, in summer, say, it would in all probability extrude its eggs within the next four or five months; whereas, if the ovary is at that time very immature, spawning will not be likely to take place until after an interval of about 14 months.

* Report of the Canadian Lobster Commission, 1898 (No. 11 C.), Ottawa, 1899.

† *Op. cit.* pp., 40–41.

‡ Coste found that *Maia squinado* spawned twice after a single impregnation (*Comptes Rendus*, XLVII., p. 49, 1858). According to the observations of Mitchell recorded by Miss Rathbun (*Proc. U.S. Nat. Mus.*, XVIII., p. 369, 1895), the females of *Callinectes sapidus* are impregnated in their third summer, after which they cease to moult, and the single impregnation suffices for all subsequent spawnings. The first spawning takes place in the fourth summer—a year after impregnation.

The evidence as to the maturity of the female crab may be summed up as follows:—A female crab becomes potentially mature when it measures about $4\frac{1}{8}$ inches across the broadest part of the back. At that size the vagina and spermatheca are for the first time sufficiently developed to admit of the introduction of the sperms into the spermatheca. The actual maturity or reproductive activity of a crab depends upon its being fertilised at the moment of casting. Of crabs between $4\frac{1}{8}$ and $5\frac{3}{8}$ inches in greatest breadth, a considerable proportion (*vide* p. 82) are not fertilised, and are consequently functionally immature. All crabs over $5\frac{3}{8}$ inches which were examined were found to be fertilised. While, then, all females over $5\frac{3}{8}$ inches are probably active in reproduction, a proportion, possibly greater than the half, of those between $4\frac{1}{8}$ and $5\frac{3}{8}$ inches, are also mature. With regard to spawning, a crab, as a rule, carries at least two batches of eggs in succession. It then casts, possibly soon after the hatching of the last lot of eggs, and may again spawn within the following four or five months, or not until after an interval of about 14 months. The latter seems to be more often the case. And as to casting, certain facts seem to point to the possibility of the crab not casting until a considerable time after hatching has taken place. We thus have a reproductive period of at least two successive years, followed by an interval of growth to be succeeded by another reproductive period—annual spawning; biennial or triennial growth.

Times of Spawning and Hatching.

The crab, according to Wilson,* spawns in November, December, and January. The observations of Meek and Cunningham confirm this statement. A crab extruded its eggs in the beginning of December in the tank at the Bay of Nigg, another which had been kept in the creek at Dunbar was found to be berried in December. The crab spawns offshore in deep water, and in summer migrates to the warm water near the shore. In June, Mr. Buglass, Berwick-on-Tweed, informs me, berried crabs are caught in considerable numbers in creels shot on a sandy bottom near the shore. According to information supplied by fishermen of Dunbar, they are to be found in July on the sandy bottom of Belhaven Bay. A proof of the inshore migration of the berried crab is mentioned by Meek.† Mr. Douglas of Beadnell, marked a berried crab, and set it free 3 miles from the shore in March. It was re-caught about a quarter of a mile offshore in July, and was then clean hatched.

The newly-spawned eggs of the crab are orange in colour. In May and June the orange colour has given place to a more or less reddish colour. The large black eyes of the embryo are in most cases already prominent. When the eggs are ready to hatch they have a dirty grey appearance. Of 24 berried crabs which were kept in the tanks at Dunbar, 17 hatched out in July, and two during the first half of August; the remaining five died. When the larva hatches it is not very active; within fifteen minutes after its escape from the egg it moults, and appears as a zoëa of the second stage, which is represented in Fig. 4, Pl. I. The zoëa of the shore crab (*Carcinus mœnas*) resembles much the larva of the edible crab, but differs from it in not possessing the large lateral spine of the carapace (Fig. 2). Meek concluded that on the Northumberland coast hatching takes place in July and August. The same seems to hold good for the Dunbar district. The period of incubation would thus be seven to eight months.

When the eggs are ready to hatch the female moves its abdomen

* *Op. cit.*, 1893, pp. 5, 6, 7.

† *Op. cit.*, 1899, pp. 52, 53.

slowly backwards and forwards, in this way facilitating the escape of the larvæ. The swimmerets seem to move independently of one another; the bunch of eggs attached to each swimmeret is sharply separated from those on either side of it. This is not the condition in the crab which has just extruded its ova. At that time the eggs form a large spherical mass in which there is no sign of division between the masses of eggs of the different swimmerets.

During the progress of this research it was discovered that the Fishery Board had not the power, which is possessed by the District Committees in England, to permit the possession of berried crabs for purposes other than for bait. A number of berried crabs were obtained in ignorance of this difficulty, and the evidence which they bring to bear upon the different questions treated has been incorporated in the paper.

Number of Eggs of the Crab.

Spence Bate found in one she-crab 2,000,000 ova; Buckland states, as the result of a calculation made by his secretary, that the crab carries no less than 1,441,000 eggs. An approximate calculation of the number of eggs carried by different crabs is given below. The number varies greatly with the individual. The method adopted in the estimation was as follows. The swimmerets with the eggs attached were preserved in spirit. They were then dried in a water bath and weighed. From the weight thus obtained was subtracted the weight of the dried swimmerets of a crab of the same size, but which was not berried. The weight of the eggs was thus found approximately. The weight of the hardened cement by which the eggs were attached to the swimmerets was neglected. The number in a small weight of the eggs was counted, and from that datum the total was deduced.

THE NUMBER OF EGGS CARRIED EXTERNALLY BY DIFFERENT CRABS.

	Size of Crab.—Greatest Breath.	Estimated Number of Eggs.
1	$5\frac{3}{4}$ inches.	460,000
2	$5\frac{3}{4}$ „	750,000
3	$5\frac{15}{16}$ „	1,010,000
4	6 „	940,000
5	$6\frac{5}{16}$ „	1,480,000
6	$7\frac{11}{16}$ „	3,000,000

From the data given above there appears to be an increase in the number of eggs with an increase in the size of the crab. In the case of two crabs measuring $5\frac{3}{4}$ inches, the numbers of eggs were found to be 460,000 and 750,000 respectively, while in the crab $7\frac{11}{16}$ inches in breadth the number of the eggs attached to the abdomen was estimated at about 3,000,000. Herrick * found that the larger lobsters carried a far greater quantity of eggs than the smaller specimens. A lobster, 8 inches in length was found to have on an average 5000 eggs, while in those measuring 15–19 inches 80,000 to 90,000 were observed in certain examples, the averages in that range of size being 46,000 to 77,000 eggs. From an examination of 4645 berried females Herrick deduced the following law:—"The numbers of eggs produced by female lobsters at each reproductive period vary in a geometrical series, while the lengths of the lobsters producing these eggs vary in an arithmetical series." How far this law is applicable to the crab extended investigation is required to show.

* *Op. cit.*, pp. 51, 52.

TABLE I.—DISSECTION OF FEMALE CRABS CAUGHT IN CREELS, 1897-1900.

S. designates a soft crab; H. a hard crab; H, a crab which is very nearly, but not quite, hard.

Month.	Number of Specimens.	Condition of Shell.	Sizes in Inches. Greatest Breadth.	Ovary.	Eggs. (Size in mm.)	Spermatheca.	Secretion of Spermatheca.
May.	1	S.	$7\frac{2}{16}$.	—	—	Plugged.	—
Aug.	12	S.	$3\frac{6}{16}$: $3\frac{8}{16}$: $3\frac{11}{16}$: $3\frac{13}{16}$: $3\frac{15}{16}$: $4\frac{1}{16}$: $4\frac{3}{16}$: $4\frac{5}{16}$: $4\frac{7}{16}$: $4\frac{9}{16}$: $4\frac{11}{16}$.	Immature	—	Not plugged; unfertilised.	Small amount fluid.
,,	3	S.	$4\frac{1}{16}$: $4\frac{3}{16}$: $4\frac{11}{16}$.	,,	Small, transparent.	Plugged; large amount sperms.	Large amount fluid.
,,	8	S.	$4\frac{1}{16}$: $4\frac{3}{16}$: $5\frac{1}{16}$: $5\frac{1}{16}$: $5\frac{1}{16}$* : $5\frac{3}{16}$: $5\frac{13}{16}$: $6\frac{1}{16}$.	White.	·15—·17.	,, ,, †	Varied amount fluid.
,,	6	S.	$5\frac{1}{16}$: $5\frac{1}{16}$: $5\frac{3}{16}$: $5\frac{11}{16}$: $5\frac{13}{16}$: $5\frac{15}{16}$.	Immature.	Small, transparent.	,, ,,	Bright amber fluid.
,,	1	S.	$5\frac{2}{16}$.	,,	Largest—·12.	,, ,, †	,, ,,
,,	1	S.	$5\frac{3}{16}$.	Orange coloured.	·15.	Plugged.	Semi-fluid.
Sept.	3	S.	$5\frac{2}{16}$: $6\frac{2}{16}$: 7.	—	—	Plugged; large amount sperms. †	—
Oct.	9	S.	$4\frac{6}{16}$: $5\frac{1}{16}$: $5\frac{6}{16}$: $5\frac{8}{16}$: 6 (*) : $6\frac{1}{16}$: $6\frac{4}{16}$: $6\frac{6}{16}$: $6\frac{8}{16}$.	Pale orange.	—	,, ,,	Large amount; gelatinous.
,,	5	S.	$6\frac{1}{16}$: $6\frac{1}{16}$: $6\frac{4}{16}$: $6\frac{14}{16}$: $7\frac{1}{16}$.	White.	·1—·15.	,, ,,	,, ,,
,,	2	S. & H.	$6\frac{1}{16}$: $5\frac{7}{16}$ (No. 863).	Pale white.	—	No plugs; small amount.	Shrunk; disc-like.
,,	2	H.	$5\frac{2}{16}$ (No. 991) : — (No. 837).	,,	·1 (No. 991).	,, unfertilised.	Small amount.
,,	2	S.	$5\frac{3}{16}$: $5\frac{6}{16}$ (No. 903).	,,	—	,, ,,	Small and large amounts respectively.
Nov.	3	S.	$5\frac{1}{16}$ (No. 1029) : $5\frac{4}{16}$ (No. 1167) : $6\frac{1}{16}$ (No. 1025).	,,	·1—·12 (No. 1025).	Plugged; large amount.	Large; gelatinous.
,,	1	S.	$6\frac{7}{16}$ (No. 1118).	,,	—	,, ,, *	Becoming hard.
,,	2	H. & S.	$5\frac{6}{16}$: $5\frac{14}{16}$.	,,	—	No plugs; ,,	Pale amber.
,,	2	S. & H.	$5\frac{1}{16}$ (No. 1045) : $5\frac{6}{16}$ (No. 880).	Small.	—	,, unfertilised.	—

* Plug in right vagina alone. † Spermatophores also present in certain specimens.

The crabs, to which the numbers in brackets are attached, were labelled crabs used in the migration experiments, p. 119.

TABLE I.—DISSECTION OF FEMALE CRABS CAUGHT IN CREELS, 1897-1900—*continued.*

S. designates a soft crab; H. a hard crab; H, a crab that is almost hard.

Month.	Number of Specimens.	Condition of Shell.	Sizes in Inches. Greatest Breadth.	Ovary.	Eggs. (Size in mm.)	Spermatheca.	Secretion of Spermatheca.
Nov.	2	H. (C.)*	5 (No. 697) : 5⅜ (No. 1019).	Pale white.	—	No plugs; fair amount.	Shrunk to solid condition.
Dec.	7	S.	5¼ : 5⅛ : 5⅜ (No. 1144) : 6 7/16 : 6⅛ : 7¼ : 7⅛.	,, ,,	—	Plugged: large amount.	Fluid solidifying and solid.
,,	3	S.	6 (No. 1063) : 6⅜ (No. 1153) : 6 7/16.	,, ,, (6 7/16).	·15 (6 7/16).	No plugs; small amount. ‡	Shrunk (No. 1063).
,,	3	H. (C.)	5¾ (No. 1018) : 5⅞ (No. 1020) : 6 5/16 (No. 1014).	White.	·2 (No. 1014).	,, fair amount.	Semi-solid and solid.
,,	1	H. (C.)	7⅛ (No. 1013).	Orange.	·2—·24.	,, ,,	Darkening fluid.
,,	1	H. †	5 5/16.	Scarlet.	·34.	,, ,,	Solidified.
,,	1	H. †	6¼.	Immature.	—	,, considerable amount.	—
,,	1	H. †	6 7/16.	Pink.	·15—·24.	,, ,,	Considerable amount of fluid in right; solid in left.
,,	1	H.	4½ (No. 841).	Pale white.	—	,, unfertilised.	—
Jan.	1	H. clean	4⅝.	—	—	Large amount of sperms.	Shrunk and disc-shaped.
,,	2	H. ,,	5 (No. 957) : 5 5/16 (No. 892).	Pale.	—	Unfertilised.	—
,,	14	H. ,,	3 : 3¼ : 3⅜ : 3½ : 3 5/16 (S.) : 3 5/16 : 3 5/16 : 3 5/16 : 3⅜ : 3⅜ : 3⅝ : 3⅝ : 4 : 4⅛.	,,	—	,,	—
Feb.	2	H. ,,	5 3/16 : 7 1/16.	Orange.	·15, ·2, ·22.	Large amount of sperms.	Shrunk.
,,	2	H. ,,	5 1/16 : 5¾.	Pale.	—	,, ,,	,,
,,	1	H. ,,	4¾.	,,	—	Unfertilised.	—
May.	4	H. ,,	6 7/16 : 6⅜ : 6 3/16 : 6⅛.	Red and scarlet coral.	—	Fertilised.	—
,,	1	H. ,,	6.	Reddish.	—	—	—

The crabs marked (C.) had been kept for some time in confinement. † "China" crab. ‡ No sperms in left spermatheca of No. 1063.

TABLE I.—DISSECTION OF FEMALE CRABS CAUGHT IN CREELS, 1897-1900—*continued.*

S. designates a soft crab; H. a hard crab.

Month.	Number of Specimens.	Condition of Shell.	Sizes in Inches. Greatest Breadth.	Ovary.	Eggs. (Size in mm.)	Spermatheca.	Secretion of Spermatheca.
May.	1	H. clean	$6\frac{3}{8}$.	—	Small eggs.	—	—
June.	3	H.	$5\frac{5}{16}$: $5\frac{1}{4}$: 6	Immature.	—	Fertilised.	—
,,	4	H.	$5\frac{3}{8}$: $6\frac{7}{16}$: $6\frac{5}{16}$: $6\frac{1}{16}$.	Red coral.	—	,,	—
,,	1	H.	$5\frac{3}{16}$.	Unripe.	—	—	—
,,	1	H.	$4\frac{15}{16}$.	,,	—	Unfertilised.	—
July.	6	H.	$5\frac{1}{2}$: $5\frac{3}{4}$: 6 : $6\frac{1}{2}$: $7\frac{1}{16}$: $8\frac{5}{16}$.	Scarlet; Pink ($8\frac{5}{16}$).	—	Fertilised.	—
,,	1	H.	$5\frac{1}{4}$.	Immature.	—	,,	—
,,	2	H.	$4\frac{1}{2}$: 5.	,,	—	—	—
,,	8	H.	$3\frac{1}{8}$: $3\frac{1}{2}$: $3\frac{5}{8}$: $3\frac{11}{16}$: 4 : $4\frac{1}{8}$: $4\frac{1}{8}$: $4\frac{1}{4}$.	,,	—	Unfertilised.	—
Aug.	5	H.	$5\frac{5}{16}$: $5\frac{11}{16}$: $5\frac{13}{16}$: $6\frac{1}{2}$: $6\frac{13}{16}$.	Large; red coral.	·22—·29.	Fair amount of sperms.	Shrunk.
,,	1	H.	$5\frac{3}{8}$.	Orange.	·2, ·22, ·24.	—	,,
,	3	H.	$4\frac{1}{2}$: $4\frac{3}{4}$: $4\frac{11}{16}$.	White.	·1.	Unfertilised.	—
Oct.	2	H.	$5\frac{3}{8}$: $6\frac{3}{8}$.	Red.	·39—·44.	Fertilised.	A quantity of fluid.
,	2	H.	5 : $5\frac{1}{4}$.	Pink and yellow.	·15—·2.	,,	Solidified.
,,	1	H. dirty	$4\frac{5}{16}$.	—	—	,,	,,
,,	4	H.	$3\frac{5}{16}$: $3\frac{13}{16}$: $3\frac{15}{16}$: $4\frac{5}{16}$	Immature.	—	Unfertilised.	—
Nov.	2	H. (C.)*	$5\frac{7}{16}$ (No. 632) : $5\frac{3}{8}$.	Orange.	—	Empty.†	

* The crabs marked (C.) had been kept for some time in confinement.

† Left vagina absent.

TABLE I.—DISSECTION OF FEMALE CRABS CAUGHT IN CREELS, 1897-1900—*continued.*

S. designates a soft crab; H. a hard crab.

Month.	Number of Specimens.	Condition of Shell.	Sizes in Inches. Greatest Breadth.	Ovary.	Eggs. (Size in mm.)	Spermatheca.	Secretion of Spermatheca.
Dec.	1	H.	$\frac{3}{16}$.	Immature.	—	Fertilised.	[Apparently about to cast.]
,,	1	H.	$4\frac{15}{16}$.	—	—	,,	—
,,	1	H.	$5\frac{1}{16}$.	Pale white.	- -	Unfertilised.	—
,,	1	H. (C.)*	$6\frac{1}{16}$.	Orange.	·24—·27	Fertilised.	Shrunk.
,,	1	H. (C.)	$6\frac{1}{2}$.	Ripe.	Ripe	,,	,,
,,	1	H. (B.)† (C.)	$5\frac{15}{16}$.	Pale.	—	Fair amount.	—
Feb.	1	H. (C.)	$6\frac{3}{16}$.	Ripe.	·39.	Large amount.	—

* The crabs marked (C.) had been kept for some time in confinement. † B. signifies berried.

TABLE II.—DISSECTION OF BERRIED CRABS AND CRABS WHOSE EGGS HAD HATCHED LATELY.

1898-1900. Month.	Size in Inches.		Condition of Shell.	Ovary.	Eggs. (Size in mm.)	Spermatheca.	Secretion of Spermatheca.
November.	$6\frac{A}{16}$.	B.*	Yellow : dirty.	Large, red.†	—	—	—
,,	$5\frac{3}{4}$.	B.	Clean.	Whitish: 4 ripe eggs left in ovary.	—	Large quantity of sperms.	Shrunk.
,,	$5\frac{3}{4}$.	B.	Dirty.	Greenish.	About ·1.	Considerable quantity of sperms.	—
December.	$5\frac{1}{2}$.	B.	,,	White, with ripe eggs left in ovary.	—	Little white patches.	—
February.	6.	B.	Clean.	Pale white: red eggs in ovary.	—	Very few sperms.	—
May.	$7\frac{1}{16}$.	B.	,,	Red coral.	—	A quantity of sperms.	—
July.	$5\frac{1}{8}$ (No. 646).	B.	—	White.	—	Little in left : large quantity in right.	—
,,	$5\frac{7}{16}$ (No. 649).	B.	Rather dirty.	White, with tinge of red.	Fairly large.	A few sperms in right spermatheca.	—
,,	$5\frac{3}{4}$ (No. 695).	E. h. ‡	—	Pale pink.	—	Large quantity of sperms.	—
,,	$6\frac{1}{2}$ (No. 694).	E. h.	—	Red coral.	—	,, ,,	—
,,	$6\frac{1}{2}$ (No. 639).	E. h.	—	Large : red coral.	—	,, ,,	—
August.	$5\frac{3}{4}$.	E. h.	—	Orange.	—	—	—
,,	$6\frac{A}{16}$.	E. h.	Rather dirty.	Pink.	—	Fairly large amount.	Shrunk.
,,	$6\frac{1}{2}$.	E. h.	,,	Greyish.	About ·15.	Large quantity of sperms.	—
,,	$6\frac{3}{4}$.	E. h.	Fairly clean.	Pink.	About ·2.	,, ,,	Shrunk.
,,	$6\frac{3}{16}$.	E. h.	—	Orange.	About ·2—·22.	Fair amount ,,	Shrunk : a little fluid.
,,	$6\frac{1}{16}$.	E. h.	,,	Large : red coral.	Large and small eggs.	,, ,,	,,

* B. signifies berried. † Apparently in the act of extruding the ova.
‡ E. h. signifies that the eggs had hatched lately, the proof of this being the presence of empty egg-capsules on the swimmerets.

TABLE II.—DISSECTION OF BERRIED CRABS AND CRABS WHOSE EGGS HAD HATCHED LATELY—*continued.*

1898-1900. Month.	Size in Inches.		Condition of Shell.	Ovary.	Eggs. (Size in mm.)	Spermatheca.	Secretion of Spermatheca.
August.	6 1/16.	E. h. *	Fairly clean.	Large; red coral.	——	Large amount.	Shrunk.
October.	4 3/8.	E. h.	Dirty.	Red.	About ·34.	Sperms not found.	Small; gelatinous.
,,	5 1/2.	E. h.	,,	Pale green.	Small.	Small amount of sperms.	Shrunk.
,,	5 5/16.	E. h.	,,	,,	——	A few sperms in left.	Pale amber-coloured fluid.
,,	5 5/16.	(?)	Dark brown.	Orange.	About ·2.	No sperms.	A quantity of fluid.
,,	5 3/8.	E. h.	——	Bright red.	,, ·49—·51.	Numerous sperms.	Shrunk.
,,	5 7/16.	E. h.	——	Orange.	,, ·37—·441.	,, ,,	——
,,	5 3/8.	E. h.	Dirty.	Red.	——	Small amount of sperms.	Shrunk.
,,	5 1/16.	E. h.	Yellowish.	Reddish.	Red eggs, ·17—·22. White eggs, ·15—·2.	,, ,,	,,
,,	5 1/16.	E. h.	Fairly clean.	Red.	·34—·37.	,, ,,	——
,,	5 3/16.	E. h.	Dirty.	Pale white.	——	——	——
,,	6 1/8.	E. h.	,,	Orange.	·39.	Some sperms.	——
,,	6 3/8.	E. h.	,,	Large; bright red.	·32.	Small amount of sperms.	Shrunk.
,,	6 3/8.	E. h.	Clean.	,, crimson.	·39.	,, ,,	,,
,,	7 1/8.	E. h.	,,	Orange.	·39—·41.	Sperms.	,,
November.	5 3/8.	E. h. (C.)†	——	Orange.	——	——	——
December.	5 1/16.	E. h.	Dirty.	Ripe; red.	·44; capsule, ·49—·7.	Fair amount of sperms.	Shrunk, hard.

* E. h. signifies that the eggs had hatched lately, the proof of this being the presence of empty egg-capsules on the swimmerets.
† The crabs marked thus (C.) had been kept in confinement from the preceding June when they were berried.

TABLE II.—DISSECTION OF BERRIED CRABS AND CRABS WHOSE EGGS HAD HATCHED LATELY—*continued.*

1899-1900. Month.	Size in Inches.		Condition of Shell.	Ovary.	Eggs. (Size in mm.)	Spermatheca.	Secretion of Spermatheca.
December.	6 $\frac{5}{16}$.	E. h. *	Dirty.	Full; orange.	·37—·41.	Fair amount of sperms.	——
,,	6$\frac{1}{2}$.	E. h.	,,	Pale.	——	,, ,,	Copious secretion of fluid.
,,	6$\frac{1}{2}$.	E. h.	,,	Pink.	29, ·32.	Large amount ,,	——
,,	6 $\frac{7}{16}$.	E. h.	,,	Reddish.	—·39.	No sperms made out.	Considerable amount of fluid.
,,	5$\frac{1}{2}$.	E. h. (C.)†	——	Large; orange.	·24—·27.	Considerable amount of sperms.	Shrunk, hard.
,,	6$\frac{1}{2}$.	E. h. (C.)	——	Pale pink.	·15.	Large ,, ,,	——
,,	6$\frac{1}{2}$ (No. 678).	E. h. (C.)	Dirty.	Orange.	·24.	,, ,, ,,	Shrunk.
,,	6$\frac{1}{2}$.	E. h. (C.	,,	,,	·24, ·27.	Moderate ,, ,,	——

* E. h. signifies that the eggs had hatched lately, the proof of this being the presence of empty egg-capsules on the swimmerets.
† The crabs marked thus (C.) had been kept in confinement from the preceding June when they were berried.

The Mature Male Crab.

The male crab is ripe at a somewhat less size than the female. The condition of maturity in the male is the presence of ripe male elements in the vas deferens. The sperms of the edible crab are not unlike those of *Carcinus mœnas*, as described by Grobben*. They are disc-shaped when seen from above; in the centre appears a small refractile body containing a nucleus; the periphery of the disc is transparent and delicate. (Fig. 11, a, Plate I.) When seen from the side the sperm is seen to be spindle-shaped. (Fig. 11, b, *ib.*) In contradistinction to those of *Carcinus*, the edge of the disc is smooth, not serrated. The sperms are not found free in the vas deferens, but are packed in capsules—spermatophores. The opening of the vas deferens to the exterior is on the apex of a membranous papilla situated on the first joint, coxopodite, of the last thoracic limb (*cp.* Brocchi†). The presence, then, of spermatophores in the vas deferens is the character of a ripe male. They are to be found in crabs as small as $3\frac{1}{4}$ inches across the back. In crabs of this size, and certain others up to $4\frac{1}{8}$ inches, the vas deferens is of small diameter, colourless and tense as a crystalline rod. It encloses a colourless fluid, which consists essentially of minute fatty corpuscles, with a few spermatophores. Between $3\frac{1}{4}$–$4\frac{1}{8}$ inches most of the crabs exhibit vasa deferentia of this description. Above $4\frac{1}{8}$ inches, however, the vas deferens is white, the colour being due to the great numbers of spermatophores which it contains. A still further stage of development is seen in the extraordinarily swollen condition of the sperm-duct in most adult hard crabs. (In all conditions of the vas deferens the colourless fluid containing the fat corpuscles is present also.) In the adult male, when the swollen vas deferens is torn, the contents flow out profusely through the contraction of the muscular wall of the duct; and if the membranous genital papilla is pressed, spermatophores are expelled. It is very probable that this swollen turgid condition will materially aid, if it is not necessary for, the act of fertilisation. The vas deferens of a very soft male crab is of small diameter, though white in colour. In such a case no spermatophores may be extruded in response to pressure of the papilla. As the crab hardens, however, the diameter of the sperm-duct increases greatly, and there is conclusive proof that a male crab, even before it becomes quite hard, may fertilise a female (*vide* above—Fertilisation, p. 83). In hard crabs smaller than $3\frac{1}{4}$ inches across no spermatophores were made out, and in six hard crabs, measuring from $3\frac{1}{4}$ to $4\frac{1}{8}$ inches, none were noticed. (*Vide* Table III., p. 98.) Seventeen hard crabs, from $3\frac{1}{4}$ to $4\frac{1}{8}$ inches, showed colourless vasa deferentia containing spermatophores; six between these limits had white sperm-ducts; above $4\frac{1}{8}$ inches all hard crabs had white and swollen vasa deferentia. All male crabs, then, above $4\frac{1}{8}$ inches are probably mature. In the case of the female crab, the observations made so far indicated $4\frac{1}{8}$ inches as the smallest size of maturity. Certain male crabs are, however, mature at a smaller size.

In Table III. the description is given of the condition of the vas deferens in 124 crabs. These observations cover the period from May to December inclusive. I, however, have no doubt that the male crab is ripe during the whole year, the only event which will interfere with its reproductive activity being casting.

The smallest ripe male observed by Wilson‡ was 5 inches across.

* "Beiträge zur Kenntniss der männlichen Geschlechtsorgane der Dekapoden," *Arbeiten aus dem Zoologischen Institut der Universität*, Wien., T. i., 1878.

† "Recherches sur les organes génitaux males des Crustacés décapodes," *Annales des Sciences Naturelles, Zoologie et Paléontologie*, T. ii., 1875.

‡ *Op. cit.*, p. 7.

III.—Dissection of Male Crabs Caught in Creels.

S. indicates soft crab; H. hard crab.

1899–1900. Month.	Number.	Condition.	Sizes in Inches.	Vas Deferens.	Spermatophores.
May.	6	H.	6 : 6 5/16 : 6 7/16 : 6 1/2 : 6 1/4.	Large; swollen; white.	Present.
June.	3	H.	4 7/16 : 5 1/16 : 5 3/4.	,, ,, ,,	,,
July.	14	H.	4 : 4 1/16 : 4 3/16 : 4 3/8 : 4 1/2 : 4 1/2 : 4 3/4 : 5 1/16 : 5 3/8 : 5 3/8 : 5 1/2 : 5 5/8 : 6 1/4 : 6 7/16.	,, ,, ,,	,,
,,	4	H.	3 5/16 : 4 : 4 1/16 : 4 3/16.	Pale; white.	,,
,,	5	H.	3 : 3 3/4 : 3 1/2 : 3 1/4 : 4 1/4.	Pale.	,,
Aug.	9	S.	4 7/16 : 4 1/2 : 4 3/4 : 5 1/16 : 5 1/16 : 5 1/2 : 5 5/8 : 5 1/2 : 7 3/8.	Swollen; white.	,,
,,	5	S.	3 5/16* : 4 5/16 : 4 3/4 : 4 1/2 : 5 1/2.	White.	,,
,,	5	S.	3 1/2* : 3 1/2 : 4 : 4 1/2 : 4 5/16.	Pale.	,,
,,	4	S.	3 1/2 : 3 1/2 : 3 1/2 : 4 1/2.	,,	Not made out.
,,	3	S.	4 7/16 : 4 5/16 : 4 3/4.	Swollen.	Present.
Sept.	670	H.	Over 4 1/4.	Large; swollen; white.	,,
Oct.	6	S.	5 1/16 : 5 3/4 : 5 1/2 : 5 1/2 : 6 1/2.	Swollen; white.	,,
,,	6	H.	4 1/2 : 4 1/2 (No. 973) : 5 1/8 (No. 897) : 5 1/4 : 5 3/8 : 5 3/4.	Large; swollen; white.	,,
,,	3	H.	4 1/2 (No. 831) : 4 1/2 (No. 994) : 4 1/2 (No. 886).	Pale; white.	,,
,,	11	H.	3 1/2 † : 3 1/2 : 4 3/4 : 4 5/8 : 5 1/16 : 5 3/16 : 5 1/4 : 5 3/8 : 5 7/16 : 5 1/2 (No. 673) : 5 3/4.	Large; swollen; white.	,,
,,	2	H. ‡	4 1/16 : 4 1/2.	Thin; pale; white.	,,
Nov.	5	S.	5 1/2 (No. 1115) : 5 1/2 (No. 1135) : 5 1/4 : 6 1/2 (No. 1084) : 6 5/16.	Thin; white.	,,
,,	9	H.	4 1/2 (No. 835) : 4 1/2 : 5 (No. 1039) : 5 1/2 : 5 1/2 (No. 1136) : 5 1/2 : 5 1/4 (No. 1082) : 5 1/2 : 7 (No. 1172).	Moderate thickness; white.	,,
,,	1	H.	6 1/2.	Large; swollen; white.	,,
,,	1	H. ‡	4 1/2 (No. 1000).	Small; pale.	,,
Dec.	1	S.	3 3/4.	Pale.	,,
,,	4	H.	4 1/2 (No. 1140) : 5 1/2 : 5 1/2 (No. 1064) : 6 3/4 (No. 1111).	Large; swollen; white.	,,
,	2	H.	5 5/16 (No. 1104) : 5 7/16 (No. 1166).	Small; white.	,,
,	4	H.	3 1/2 : 3 1/2 : 3 1/2 : 4.	,, ,,	,,
,,	8	H.	3 1/4 : 3 1/2 : 3 1/2 : 3 1/2 : 3 1/2 : 3 1/2 : 3 1/2 : 3 1/2.	Small; pale.	,,
,,	2	H.	3 5/16 : 3 1/2.	Pale.	Not made out.

* Hard crab. † Vas deferens crowded with spermatophores. ‡ Just become hard.

External Sexual Characters.

The male may be readily distinguished from the female crab by three external characters. These are, in the order of their importance:—(1) The presence of intromittent organs on the first and second abdominal segments of the male, and, in the female, of four pairs of swimmerets on the abdomen, and the two vulvæ on the fourth thoracic segment; (2) the shape of the abdomen, which in the male is narrow, in the female broad; (3) the form of the carapace, which in the female is more convex

and higher than in the male. In regard to the last feature, the crenate edge of the carapace of the male is broader than that of the female, and is also turned upwards. (Compare Fig. 10 (a, male; b, female), Plate I., which represents the shells of two crabs of the same size, viz., 6½ inches.) Of the three sexual characters, the first, viz., the external genital organs, is alone diagnostic for all crabs. Thus, it is possible to distinguish the sex of a crab when it is little more than a quarter of an inch in breadth. The second and third characters are only applicable within limits. Thus, the difference in shape of the abdomen will be found sufficiently defined in crabs of 2½ inches and upwards; while the shape of the shell as a sexual distinction is of little value except in crabs over 4 inches in breadth. In other words, the last character is of moment only in mature crabs. An additional feature which is especially noticed in crabs over 5 inches in breadth is the comparative size of the biting claws in the male and female. In the former the claws are very much larger than in the latter. Buckland mentions that in certain places the fishermen were accustomed to send the claws alone of the large male to market, the body being either used for bait or thrown away. While, then, the external organs of generation are a primary sexual character, the shape of the abdomen and shell, and the comparative size of the large claws, are secondary diagnostic sex features.

The testes and ovaries are paired; there is, however, a communication between the right and left testes, and also between the right and left ovaries.

Proportional Numbers of the Sexes.

In order to arrive at the proportional numbers of the sexes, two large groups of crabs have been examined—(1) The small crabs which are found on the beach, and (2) the crabs caught in the creels of the fishermen. The beach crabs were collected twice a month during a year; their sex and size were noted (Tables IV. and VIII.). The number of male and female crabs in 20 catches of the fishermen at Dunbar were counted. In the list each month of the year is represented (Table V.). Statistics of the catches of crabs at Crail were kept by Mr. A. W. Brown, St. Andrews.* In Table VI. the numbers of males and females in 30 catches, representing each month of the period February to September inclusive, are recorded. A distinction has been made in the case of the creel crabs between crabs of legal size, 4¼ inches, and those under that minimum. The lists of undersized crabs are not, however, likely to be so exact as those of the gauge crabs, since in some cases, for example at Crail, they are often thrown overboard at sea. At Dunbar, with few exceptions, the fishermen were asked to bring ashore every crab of the catch which was to be enumerated.

The numbers of crabs collected each month on the beach are detailed in Table IV.; the hard and soft crabs are separately recorded. Of a total of 2332 crabs (for the sizes of which see Table VIII.) collected on the beach, 1154 were males and 1178 females. This shows a slight preponderance of females. To every 100 females there were 98 males. The crabs were collected without any selection either as to sex or size, and, so far as the total number warrants, may probably be regarded as a fair sample of the crabs which make the beach their habitat.

The creel crabs (hard and soft taken together) were recorded in two divisions, gauge and under-gauge crabs. In the 20 Dunbar catches there were of the under-gauge crabs, 909 males and 623 females, *i.e.*, for every 100 females 146 males; while at Crail, where only 390

* By kind permission of Professor M'Intosh.

undersized crabs were recorded for 30 catches, 188 were males and 202 females, giving for each 100 females 93 males.

In respect of the gauge crabs, of the total of 5690 Dunbar crabs the males numbered 2916 and the females 2774, a proportion to every 100 females of 105 males. At Crail, of 4458 crabs, 2644 were males and 1814 females; the preponderance of the males was more marked than at Dunbar, 100 females being accompanied by 146 males. The Crail statistics suffer in one respect, namely, that the crab fishing is not carried on after September. There are therefore no statistics for the winter months, when the proportion of females is probably to a slight extent raised by the appearance in the creels of females which had been berried during the first half of the year. The total number of males and females among the beach crabs, and the undersized and gauge crabs of the Dunbar and Crail catches, are given in Table VII.. The number of males to 100 females in each case and each locality is recorded. If the crabs from Dunbar and Crail are added together we get slightly different results—viz., for the undersized crabs 133 males to 100 females, and for the gauge specimens 121 males for 100 females. While, then, in the small crabs of the beach measuring from $\frac{1}{4}$ up to $3\frac{7}{8}$ inches there appears to be a slight majority in females, in the adult creel crabs the majority is on the side of the males.

There remains the question as to whether or not there are during the year seasons when the numbers of the male sex usually predominate in the catches of the fishermen, and other seasons when female crabs are in the majority. Thus Meek * says, on the evidence of Mr. Douglas, Beadnell:—"There is a majority of male crabs early in the year, but this majority is small, and continues so up to the end of April; in July and August the majority of females is very great, and this is the case until the end of September, when the male leaves the female." According to Wilson,† "almost all the market crabs taken towards the end of the year are females; . . . after the end of January there is frequently a great excess of males in the creaves." Cunningham ‡ found among the market crabs of Cornwall (Cadgwith) a majority of females. The number of males, which is small at the beginning of the crab-fishing season (May to end of September), increases to a maximum in June and then declines. Cunningham institutes a correlation between the numbers of male crabs caught and the temperature of the sea water. He supposes the decline in the numbers of the males in July and August to be in consequence of their sexual activity at that season.

In the Crail catches (Table VII.) it is seen that in each month from February to September there was among those of gauge size a majority of male crabs, and this was the case in each catch with the exception of two, in which the female crabs were slightly more numerous. One catch in April consisted of 113 males and 119 females; another in August was composed of 21 males and 27 females. In the case of the Dunbar catches (Table V.) there is, however, much diversity in the proportions of the two sexes. Two catches in the same month in some cases do not show the same relation. For example, of the two February catches, in one there is a majority of males; in the other the females are the more numerous. A similar relation is seen between the two catches in July. According to Wilson, the females are in the majority in autumn and winter. In two Dunbar catches in November the males are in the majority among the hard market crabs, and also

* *Op. cit.*, 1898, p. 29.

† *Op. cit.*, 1893, p. 6, and 1895, p. 5.

‡ *Op. cit.*, p. 4.

in the total hard and soft crabs. Again, if we divide the year into two portions, January to June and July to December, we get a total of 1403 males and 1401 females in the first half of the year, and 926 hard males and 1006 hard females in the second half of the year. If, however, the soft crabs are included we have 1513 males and 1373 females. The seasonal variation, then, seems to consist in a slight majority of males in the first half of the year, and a slight majority of females among the hard crabs from July to December. There are two factors which may tend to affect the relative number of the sexes caught in the second half of the year. The crabs which hatched their eggs in July and August will either probably cast, or proceed to deep water. The latter then are added to the number of marketable crabs, while the former, remaining soft during a considerable period, will not affect that number till about the end of the year. The ranks of market crabs, however, receive an accession from the crabs which have through casting arrived at a size which admits them to the gauge group. These probably are not hard much before the middle of October.

With regard to the lobster, Herrick * says that it is very probable that but little difference will be found in the numbers of the sexes.

It is very probable that the proportion between the sexes indicated by the beach crabs is more nearly that which exists in the species. The females which are berried seldom appear in the creels, and this fact tends to raise the percentage of male crabs. The statistics of the beach crabs do not suffer from any such sexual selection, and the conclusion is probably warranted that in this species the females slightly exceed the males in number; to every hundred females there are about ninety-eight males.

TABLE IV.—CRABS COLLECTED ON BEACH AT DUNBAR BETWEEN TIDE-MARKS AT LOW WATER OF SPRING TIDES.

	Hard Crabs.		Soft Crabs.	
	Male.	F'male.	Male.	F'male.
January 10th and 24th, 1898 ..	53	72	4	3
February 8th and 22nd, 1898 ..	70	92	..	1
March 10th and 25th, 1898	69	61	..	1
April 8th and 22nd, 1898	63	91	..	..
May 7th and 23rd, 1898; 26th, 1899	215	188	..	..
June 6th and 20th, 1898	76	62	9	5
July 4th and 19th, 1898	72	67	23	22
August 4th and 18th, 1898; 7th, 1899	41	30	47	75
September 2nd and 16th, 1898 ..	33	42	86	68
October 12th and 27th, 1897 ..	84*	71*	(28 ♂	and ♀)
	27*	28*	..	..
November 11th and 26th, 1897 ..	40	39	72	90
December 10th and 24th, 1897 ..	49	57	21	13
Totals	892	900	262	278

♂ 1154; ♀ 1178. * Includes soft crabs.

* *Op. cit.*, p. 78.

TABLE V.—Dunbar.—Statistics of Hard and Soft Crabs, Male and Female Crabs in 20 Catches.

Date.		Number of Creels.	Distance from Land and Bearing.	Direction in which Creels were Shot.	HARD CRABS.				SOFT CRABS.				Number of Boats employed in Crab Fishing.
					4¼ ins. and over.		Under 4¼ ins.		4¼ ins. and over.		Under 4¼ ins.		
					Male Crabs.	Female Crabs.	Male Crabs.	Female Crabs.	Male Crabs.	Female Crabs.	Male Crabs.	Female Crabs.	
Jan. 13, 1899	1 Boat.	60	3 miles E.N.E.	N. & S.	47	65	14	12	6	3	9	6	14
,, 28, 1898	,,				89	146	19	14	–	–	–	–	
Feb. 15, 1899	,,	69	3 miles E. of Catcraig.	N. & S.	67	48	7	8	4	3	–	–	14
,, 28, 1898	,,				141	192	(22)		2	–	–	–	
March 27, 1899	,,	110	7 miles N.	N.N.W. & S.S.E.	156	90	2	2	–	–	–	–	14
,, 31, 1898	,,				230	210	9	11	1	–	–	–	
April 27, 1899	,,	130	3 miles N.W.: 1 mile off shore.	N.W. & S.E.	232	250	13	10	–	–	–	–	30
May 3, 1898	,,				166	146	33	19	–	1	–	–	
,, 25, 1899	,,	60	3 miles W.	E. & W.	75	76	31	19	–	–	–	–	27
,, 27, 1898	,,		1 mile off Skateraw.		62	91	16	22	1	1	–	–	
June 3, 1899	,,	160	2 miles N.N.W.: ½-mile off land.	N.W. & S.E.	124	79	7	6	–	–	–	–	9
July 12, 1899	,,	90	Off Barnsness low-water mark.	N.W. & S.E.	64	47	9	11	3	2	2	6	5
,, 14, ,,	,,	75	½-mile off shore, 8 fms.		35	42	16	17	–	–	–	–	
Aug. 4, ,,	,,	80	½-mile off Scoughal.	E. & W.	26	77	19	5	1	8	2	4	5
Sept. 23, ,,	,,	60	2 miles E. by N.		76	104	1	1	235	144	–	–	4
Oct. 27, ,,	,,	60	2½ miles E.S.E.	N.W. & S.E.	83	160	286	104	140	87	80	40	17
Nov. 5, 1898	,,		3–4 miles off Skateraw, Mud, 24 fms.		269	206	4	1	64	32	46	49	
,, 17, 1899	,,	60	2½ miles E.S.E.	N.W. & S.E.	117	60	60	46	66	48	112	56	17
Dec. 13, ,,	,,	60	3 miles E. by N.	N.W. & S.E.	196	200	86	114	56	42	10	18	17
,, 20, 1897	,,				60	110	8	13	22	4	8	9	
Totals,					2,315	2,399	640	435	601	375	269	188	

TABLE VI.—Crail.—Statistics of Hard and Soft Crabs, Male and Female Crabs in 30 Catches.

Date. 1899.	Number of Boats the catches of which are recorded.	Number of Creels.	Distance from Land and Bearing.	Direction in which Creels were Shot.	HARD CRABS.				SOFT CRABS.		Number of Boats employed in Crab Fishing.
					4¼ ins. and over.		Under 4¼ ins.		4¼ ins. and over.		
					Male Crabs.	Female Crabs.	Male Crabs.	Female Crabs.	Male Crabs.	Female Crabs.	
February 18, . .	5 Boats.	143	1-2 miles E. or S.E.	E. & W.	279	145	5	4	-	-	20
March 18, . . .	4 ,,	273	1-2½ miles E. or S.E.	S.W. & N.E.	252	119	7	9	-	-	20
April 22, . . .	3 ,,	223	1 mile.	E. & W.	431	394	14	6	-	-	20
May 13, . . .	2 ,,	210	300 yards.	-	807	701	72	84	-	-	19
June 10, . . .	3 ,,	197	300 yards.	-	364	137	21	38	-	-	18
July 8, ...	3 ,,	144	At low-water rocks.	-	177	87	3	3	1	-	6
August 5, . . .	6 ,,	308	,, ,,	-	258	181	66	58	9	12	6
September 2, . .	4 ,,	158	,, ,,	-	66	38	-	-	-	-	4
Totals, .	30	1,656			2,634	1,802	188	202	10	12	—

Number of Market Crabs for each Creel=2·67 Crabs.

TABLE VII.—PROPORTION OF MALES TO FEMALES AMONG HARD AND SOFT CRABS.

	DUNBAR.			CRAIL.			DUNBAR AND CRAIL.		
	Males.	F'males.	Number of Males to 100 Females.	Males.	F'males.	Number of Males to 100 Females.	Males.	F'males.	Number of Males to 100 Females.
Beach Crabs . .	1154	1178	97·9	.	.	.	.	.	.
Creel Crabs. Undersized	909	623	146	188	202	93	1097	825	133
Creel Crabs. Gauge Size	2916	2774	105	2644	1814	146	5560	4588	121

EXUVIATION, CASTING, SHEDDING.

The crab, as is well known, can only increase in size by getting rid of its hard integument. This process, which is known as "casting" or "shedding," has been described for the edible crab by Jonathan Couch,* and for the lobster by Herrick.† I am indebted for the Report containing Couch's paper to the kindness of Edward Kitto, Esq., Falmouth. Within a short time after casting the shell increases in size, and after calcification the only increase which takes place in the animal is in its weight. The histological description of this process in a number of decapod crustacea has been fully described by Vitzou.‡ This part of the subject it is not proposed to enter upon at present.

When a crab is preparing to cast, the dermal areolar tissue (*tissu conjonctif* of Vitzou) is permeated with a viscid fluid, which, in addition to rendering this layer tense and elastic, gives it a characteristic amber colour. This layer extends all over the body, and is especially thick at the edge of the dorsum. When the crab casts, the shell opens along the suture between the epimera and the inturned edge of the carapace; two of the layers of the new shell (viz., the cuticle and the pigment layer) are already formed, and a slight calcification has taken place round the periphery of the carapace. During the process of casting the crab lies hid, and in the case of an adult female it is at this time fertilised. It apparently leaves its retreat only after a certain amount of calcification has taken place; it then seeks actively for food. Crabs in this condition are caught in great numbers in the crab-creels during autumn and winter. A considerable amount of attention was paid by the Royal Commission of 1876 to the destruction of the soft crabs which takes place during these seasons of the year. Buckland§ says.—"A soft crab may mean two different things. Firstly, it may mean a crab which has just cast its shell and is soft to the touch like putty; or it may mean a crab whose shell is very brittle like thin glass, in which condition it is called 'soft crab,' 'caster,' light-footed crab,' 'light crab,' 'white-bellied crab,' 'peelert,' 'puller,' 'metick,' 'seeding-crab,' 'watery crab,' 'white crab,' 'ripe crab,' 'pale crab,' 'sheer' or 'sick crab.' I myself prefer to call it 'glass crab.' These crabs have not recovered their condition after casting; they are, in fact, 'kelt' crabs. I have dissected several, and find that they contain very little else but the stomach, liver, lungs, and other viscera, but always a great deal of

* "On the Process of Exuviation and Growth in Crabs and Lobsters, etc." *Eleventh Annual Report of the Royal Cornwall Polytechnic Society*, 1843, Falmouth.

† *Op. cit.*, p. 84.

‡ "Recherches sur la Structure et la Formation des Teguments chez les Crustacés Décapodes." *Archives de Zoologie Expérimentale et Générale*, T. 10, 1882, Paris.

§ *Op. cit.*, p. 12.

water." The body fluid of the crab is not water; it is richly albuminous. On exposure to air for a little time it becomes black; and if a quantity of it is treated with picro-sulphuric acid it coagulates into a solid mass. A soft crab is characteristically coloured; the dorsum is a light brick red, the under-surface (epimera) is white; the dorsal surface of the great claws is red, the under-surface white. In a hard crab the white portions have a creamy or yellow colour. A crab remains "soft," legally, as long as it is possible to push the thumb through the shell in the gill region or near the great claws; this it is still possible to do three months after the time when the crab casts. When it is quite hard through increase in thickness and calcification of the shell, four months after casting, the general appearance of the crab has changed a little; the white portions have taken on a slight creamy colour, but otherwise the colours are bright and the shell clean. The crab is then known as a "china crab."

A crab which is not uncommon at Dunbar in autumn and winter, but found only during these seasons, is known as a "milker." It is to all appearance a hard crab; the white portions of the shell and claws have taken on a distinct cream colour. On testing it, however, the shell is found to be thin and brittle. There is a considerable amount of body fluid, but this, in contradistinction to the colourless body fluid of the normal soft crab, is white like milk. On treatment with picro-sulphuric acid it does not coagulate into a solid mass, but settles down as a somewhat flocculent precipitate. Microscopic examination reveals great numbers of small bodies which are probably the same *micrococci* described by Cuénot* as having been found in *Carcinus mænas*. The crab itself is usually small, and the hardening process has been checked by these parasites.

The Occurrence of Soft Crabs.

As to the time of the year when casting takes place, while there is evidence that the principal time of casting is from July to September (both inclusive), still, from the occurrence of soft crabs, it is to be inferred that casting takes place during a large portion of the year, viz. from May to November inclusive. I have records of adult soft crabs for every month of the year except April. In Table V., p. 102, are given statistics of catches of crabs during each month of 1899. In addition to these, I received in May two female soft crabs measuring 4½ by 6¾ inches; and in June Mr. Hutchison, Dunbar, observed a large soft male; in March he noted a soft crab 5½ inches across. Cunningham† records a crab which cast in April. In the case of the small beach crabs —the statistics of which (Table IV., p. 101) were kept by myself— some were found soft in each month of the year except April and May. One soft crab alone was found in February, and it had just cast. It would then appear that casting is not confined to the summer months; but the crabs which cast at other times of the year are probably a very small minority. The largest number of soft crabs is seen to occur in the months August to November inclusive. The statistics for October are deficient. It is not known how long a small crab remains soft, but, judging from the time which is known to elapse before hardening is completed in the adult crab, it is probably not less than two and a half months. It is also possible that a crab which casts late in the year will take longer to harden than those which cast early, say July. A large number of those found soft in November, then, might

* Cuénot, "Études physiologiques sur les Crustacés Décapodes." *Archives de Biologie*, T. XIII., 1895.

† *Op. cit.*, p. 42.

have cast in September, and those found in December and January may have cast in October. Of those got in July, August, and September, a number in each month were observed to have "just cast." As for the creel-caught crabs, comparatively few soft examples are got in July; at that time the few boats still engaged in the fishing are working close inshore. In August a number of soft crabs are to be got in shallow water along with the large dirty females, which show, by the presence of the empty egg-capsules on their swimmerets, that they have recently hatched their eggs. The soft crabs are then for the most part of small size. For example, in a catch of 176 crabs on August 6th, 1899, of the 57 soft crabs 44 were between $3\frac{1}{2}$ and $5\frac{3}{8}$ inches, while 11 only were above $5\frac{3}{8}$ inches in size. These crabs were for the most part crabs which had cast out of the immature group. When, however, the fishermen begin in the latter half of September to shoot their creels two to three miles off shore in over 20 fathoms water, they get immense numbers of soft crabs over gauge size, and including at that time a considerable proportion of very large crabs up to 7 inches. After September, with each month there is a rapid reduction in the numbers of soft crabs over $4\frac{1}{4}$ inches in size, till in January they practically disappear from the creels. In the case of the soft crabs under $4\frac{1}{4}$ inches, a larger number are taken in the creels in October than in any other month. As will be pointed out below, the small crabs appear to migrate to deep water a little later in the year than the gauge crabs. The statistics of the large crabs are probably therefore of more importance on the question under discussion. Among the crabs $4\frac{1}{4}$ inches and over in breadth, the percentage of soft crabs during the last four months of the year and January were respectively:—September, 80 per cent.; October, 55 per cent.; November, 42 per cent.; December, 22 per cent.; January, 2 per cent. (Table XIII., p. 143). From the fact that after September the numbers of large soft crabs decline rapidly, it is evident that there can be in October no considerable accession, to the ranks of the soft crabs, of crabs that cast in that month; and similarly in the following months the number of crabs which are, through becoming hard, being withdrawn from the soft class is very much greater than the number of those which are joining the same. A great number of crabs which are soft in September are hard in October. There is good reason for allowing for the hardening process during the winter months about $3\frac{1}{2}$ to 4 months; it may be taken for granted that the period will not be longer during the summer months. Thus, the large number of crabs which became hard in October very probably cast their shells some time in July; then those which cast in August and September should be hard again in November and December respectively. From the great reduction in the number of the soft crabs each month after September, it might be possible, given the average time required for hardening, by counting backwards to arrive at the month when the crabs just hardened had cast their shells. From the facts already known, however, we can get at the main casting period with fair accuracy, and this, there appears to be little doubt, is a period of three months—July, August, and September. If this is the case, we should expect to find the greatest number of soft crabs in September, because during that month we should have the soft crabs of the whole period. Those that cast in July and August would in September be still soft; in October the July crabs would become hard; in November the August casters would probably again be marketable; and so with the September crabs in December. After December and until the following August the number of soft crabs is practically negligeable. Wilson* says that casting goes on in July and August. Buckland† quotes the evidence of Mr. Hutton, Customs

Officer, Peterhead, to the effect that the female casts yearly in July, August, and September.

The question as to how long an interval elapses between casting and the complete hardening of the new shell is of considerable importance. As has been mentioned, the legal test of hardness is the impossibility of pushing the thumb through the shell. There is, so far as I am aware, only one recorded case of a crab which had been kept in confinement from the moment of casting until it was completely hard. This crab, which Meek‡ mentions, cast on August 12th, and was found at the end of December to be hard; "thus four to five months are necessary for the hardening process." This specimen was kept in a "hullie" by Mr. Douglas, Beadnell. While it is very probable indeed that confinement will retard the process, still, from a certain amount of indirect evidence which is supplied through the labelling experiments at Dunbar, the above-mentioned interval would appear to be not very much in excess of the period required by some of the crabs at least. The Dunbar labelling experiments were carried out in the first instance with a view to testing the summer and autumn migrations of the crab. For this purpose a large number of soft crabs – 999 in all—were labelled and set free in the months of July, August, September, October, November, and December; of these, about 11 per cent. were recovered after various intervals of freedom. On recapture, the condition of the shell of the crab, in addition to other characters, was carefully noted. In Tables X. and XI., the particulars referring to the condition when set free, the interval of freedom, the condition on recapture of each crab, are given in detail. In some cases also the sex and size of the crab are recorded. The crabs of each lot, although designated soft, were not all in the same stage of hardening; in other words, they had not cast their shells at the same time. While some of them were so soft and clean that they had doubtless cast within the previous few days, the shells of others had already undergone a considerable amount of calcification. Thus it happens that certain of the crabs were found to have become quite hard after an interval of 60 days (in one case after only 38 days), while six others were found to be still soft at the end of 74, 82, 83, 83, 94, and 100 days of freedom respectively. The latter crabs, while they were almost completely hard and would possibly have passed as marketable, could still have been broken over the gill cavity. In testing a crab of this stage, there is a considerable risk of lacerating the thumb on the sharp edges of the broken shell. The following Table shows the month in which the soft crabs were labelled, the time of freedom, and their condition when recaptured. The crab when it has almost completely recovered its hard condition is marked H, while the soft crab is represented by S, and the legally-hard crab by H.

* *Op. cit.*

† *Op. cit.*, p. 12.

‡ Northumberland Sea Fisheries Committee, 1898, "Report on the Trawling Excursions," Newcastle-on-Tyne, 1898, p. 28.

Month when Set Free.	Condition of Shell on Recapture.	Intervals of Freedom—Days.
July.	S	34.
	H	...
	H	86, 103.
August.	S	24, 26, 42, 49.
	H	54, 54, 60, **82, 83.**
	H	**59**, 66, 70, 113, 119, 119, 129.
September.	S	2, 2, 2, 2, 2, 3, 3, 5, 6, 11, 14, 16, 19, 21, 24.
	H	23, 28, 31, 31, 33, 49, 54, **94.**
	H	**38**, 52, 59, 92, 115.
October.	S	9, 16, 18, 20, 20, 22, 25, 29, 32, 52.
	H	24, 37, 47, **83, 101*, 103.**
	H	**61**, 80, 103, 128, 177.
November.	S	9, 9, 11, 11, 12, 14, 18, 24, 26, 26, 27, 40, 40, 41, 42, 52.
	H	54, 63, 68, **74.**
	H	97, 165, 165, 165, 184.
December.	S	10, 11, 30, 30.
	H	16, 56.
	H	...

* The crab here referred to was captured after an interval of 86 days; after 15 days in confinement, it was still not quite hard enough for market.

The crab which was not completely hard after 101 days was set free in October. All these crabs had been caught in the creels. We do not know how soon after casting a crab leaves its retreat in search of food; but the primary calcification, which renders it capable of defending itself, appears to ensue within a few days. While, then, the facts supplied by the labelling experiment do not entitle us to fix the limits of the period of hardening, we have at least evidence of the time a crab may remain soft, viz. 90 to 100 days. Since it is not improbable that the shell had been about a week old when the crab was taken first of all, and since another week would doubtless at least be required for complete hardening, we get a period of 115 days, which is practically four months. The conclusion, then, to be drawn from these data is that a crab which is soft in October may require four months before it is legally hard. We are unable to judge how far the season of the year in which casting takes place operates in aiding or retarding the process of hardening. One thing is certain, that the rapidity of recovery must be dependent on the amount of food which the crab secures, and, as this necessarily varies with the individual, there is reason to suppose that the length of the period of softness is subject to considerable variation. Although the evidence is very incomplete, I am of opinion that a crab which casts in July will recover its hardness in a shorter time than the crab which casts in September.

In the case of the lobster Herrick* considers that six to eight weeks are necessary for hardening to the condition of the old shell. Prince†

* *Op. cit.*, p. 95.

† *Op. cit.*, p. 10.

says that "a lobster is not completely hard for seven or eight weeks after moulting." A lobster which cast its shell in the tanks at Cullercoats Laboratory during the night 17th-18th August "was found" by Meek* "to be apparently quite hard on 26th August; so that the hardening appears to be a relatively quick process in the lobster." One of the lobsters confined in a floating box by Cunningham† cast on November 23rd, and was found to be hard on February 9th.

Frequency of Casting.

In its earliest stages there is reason, from the analogous case of the lobster, for believing that the young crab moults more than once a year, but in the stage immediately preceding the adult condition, from 3 to 4 inches in breadth, it probably casts only once a year. The shells of these crabs are on the whole clean, and have few ectozoa attached to them. The latter are always small; the commonest being *Serpula*, *Spirorbis*, and *Anomia*. Certain of these crabs, which have been referred to above (p. 84), and which gave evidence of not having cast during the preceding year, were found to be apparently in a diseased condition. It is very probable, indeed, that the great majority do cast once a year. A considerable number (525) of crabs measuring 3 to $4\frac{1}{8}$ inches were labelled and set free in December, January, February, March, April, May, June, and July, and of these very few were recovered. This may in a great measure be due to the fact that, owing to their annual shedding, they got rid of the labels in summer. Of the 16 which were recaptured, two were obtained in July, one in August, and one in September. None were obtained later in the year than September, that is to say after the casting period. The crab captured in August, although it was hard when set free, was then brittle and was evidently preparing to cast.

The mature crabs above $4\frac{1}{8}$ inches in breadth, there is abundant evidence to show, do not cast every year. Certain female crabs measuring from $4\frac{1}{8}$ to $5\frac{3}{8}$ inches which are unfertilised may, however, do so. The shells of the adults are found covered with a varied collection of ectozoa—viz., *Balanus*, *Serpula*, *Anomia*, *Membranipora*, zoophytes. I have also on two occasions found, in cases of injury to the gill chamber, mussels and *Saxicava* attached to the gills. Large oysters have been found attached to the backs of crabs. The size of these molluscs in certain cases proves that the crabs, their hosts, had not cast for three and four years. Buckland‡ mentions two large crabs, a male $6\frac{3}{4}$ and a female $7\frac{3}{4}$ inches, which had on their backs oysters 3 inches across. The crabs could not have cast for three years. In the *Fish Trades Gazette* for December 9th, 1899, a crab was recorded upon which was fastened a four-year-old oyster. It is now in Ipswich Museum. While from the fact that the female crab usually carries two lots of eggs in successive years we know that the female does not probably cast oftener than once in two years, we have here collateral evidence indicating even a longer abstention from casting. From an examination of the labelled crabs which were put away when soft, it is seen that certain of the ectozoa, zoophytes especially, attach themselves to the crab earlier in the year than October. All the soft crabs which had been set free up to and including the month of September, when recaptured had large growths of zoophytes, and also showed *Anomia* and *Serpula*; whereas the soft crabs of October were almost

* *Op. cit.*, p. 54.
† *Op. cit.*, p. 41.
‡ *Op. cit.*, p. 11.

devoid of ectozoa; occasionally a small zoophyte was discovered. One crab which was soft in November was found in the following May to have on its dorsum an *Anomia* $\frac{1}{4}$-inch (6·5mm.) across, and a *Serpula* $\frac{3}{8}$-inch (11mm.) long.

The labelling experiments afford some evidence with regard to the frequency of casting of the mature male. Thirty-five large hard crabs (male and female) were labelled in June and July 1899. They were set free at the mouth of the harbour, Dunbar. Of the June specimens, four males were recovered—viz., one in July, close to the harbour; one in September, 2 miles N.E. from Dunbar in 22 fathoms; two in October, 2 miles N.E., 22 fathoms, and $1\frac{1}{2}$ miles E. by S., 18 fathoms, respectively. One of the July lot, a male, was got in December 3 miles N.E. of Dunbar. These crabs then shew that the large male crabs also do not cast oftener than once in two years. As a rule, the shell of the old female crab is much more dirty than that of the male. The white parts of the shell of the male turn a deep amber colour, but it remains on the whole very free from mud. The female, however, probably from its habit, when carrying eggs, of lying half-buried in the mud, becomes very dirty, the hairs on the epimera, the fringes of the abdomen, and the exopodites of the swimmerets being often quite black.

Increase in Size on Casting.

So far the law of growth of the crab has not been investigated, and for the determination of the increase which takes place at certain sizes we are dependent on a few recorded cases. These are set out in the following Table:—

	Original Size in Inches.	Size of Soft Crab.	Increase. Inch.	Ratio of Increase.	Authority.
1	$\frac{4}{5}$	1	$\frac{1}{5}$	$\frac{1}{4}$	Mar. Lab., Dunbar.
2	$1\frac{3}{8}$	$1\frac{3}{4}$	$\frac{3}{8}$	$\frac{1}{3\cdot6}$	,,
3	$2\frac{1}{16}$	$2\frac{7}{16}$	$\frac{3}{8}$	$\frac{1}{5\cdot5}$	,,
4	$2\frac{5}{8}$	$3\frac{1}{16}$	$\frac{7}{16}$	$\frac{1}{6}$	,,
5	$2\frac{3}{4}$	$3\frac{5}{8}$	$\frac{7}{8}$	$\frac{1}{3\cdot1}$	J. Couch.
6	$2\frac{8}{10}$	$3\frac{7}{10}$	$\frac{9}{10}$	$\frac{1}{3\cdot1}$	,,
7	$3\frac{7}{8}$	5	$1\frac{1}{8}$	$\frac{1}{3\cdot4}$	Buckland.
8	4	$5\frac{1}{16}$	$1\frac{1}{16}$	$\frac{1}{3\cdot7}$	Gatty Lab., St Andrews.
9	$4\frac{3}{8}$	$5\frac{1}{2}$	$1\frac{1}{8}$	$\frac{1}{3\cdot9}$	Wilson.
10	$5\frac{1}{4}$	$6\frac{5}{8}$	$1\frac{3}{8}$	$\frac{1}{3\cdot7}$	Meek.
11	$6\frac{3}{4}$	$7\frac{1}{2}$	$\frac{3}{4}$	$\frac{1}{9}$	J. Couch.
12	$7\frac{1}{4}$	$8\frac{3}{4}$	$1\frac{1}{2}$	$\frac{1}{4\cdot8}$	Cunningham.

In the majority of cases the ratio of increase is $\frac{1}{3}$ to $\frac{1}{4}$ of the original size. In Nos. 3 and 4 the ratios were $\frac{1}{5.5}$ and $\frac{1}{6}$. These crabs were, however, measured immediately on casting, and while the skin was still pliable and putty-like. In the cases of Nos. 1 and 2 the shell had hardened sufficiently to be quite firm and resistant at the time it was measured. From the published descriptions of the remaining crabs, with the exception of Couch's specimens, I gather that they were measured some time after casting, when the shell had hardened more or less. Herrick* found, in the lobster which he observed cast its shell, that the size shortly after the moult was 12 inches, while four days afterwards it measured a little short of $12\frac{1}{2}$ inches. So far, then, it seems probable that the increase in size after casting takes place not merely immediately after the escape from the shell, but also during hardening. Until further observations have been made upon this point, the average ratio cannot be known. This question has a direct and important bearing upon the rate of growth of the crab. While, without doubt, considerable variation will be found in the increase, the cases given in the above Table, with four exceptions, point to the ratio of increase being about $\frac{1}{3}$ to $\frac{1}{4}$ of the original size.

Regeneration of Limbs—Repair of Injuries.

One of the features of the life-history of crustaceans which has attracted much attention is the renewal of limbs which have been accidentally lost. This process is intimately associated with the activity of the dermis, which results in the renewal of the whole skeleton when it has been discarded on casting. From evidence afforded by the examination of the small edible crabs, which are found between tide-marks, I am led to the conclusion that the regeneration of the appendages only takes place when the crab is preparing to cast. This view, although not expressly stated, is more or less borne out by previous investigators; it is in part suggested in the case of the larval lobster by Herrick. Thus, Réaumur† said that the new limbs of the crayfish "grow more or less rapidly, like plants, according as the season is more or less favourable; the warmer days are those which hasten the more their formation and growth. Sometimes new legs sprout out in three weeks, sometimes not till after six; and when the legs are broken off in winter, they do not grow again till summer." Chantran† found in the crayfish that "in the first year of life 70 days are necessary for the regeneration of new limbs. The adult female requires three to four years, the male one and a half to two years, to repair its limbs; and we are told that the adult male moults twice and the female but once a year." . . . "The eyes of the crayfish when cut off in October, at the end of the season of moulting, are not regenerated until the following May, when a series of moults begin." Herrick‡ says that in the 4th and 5th larval stages of the lobster—"at the moment the limb is broken off blood immediately oozes out and coagulates, forming a dense crust over the stump. In a short time a small white papilla, which represents the rudiment of the new limb, appears in the midst of the brown hardened clot. The papilla continues to grow independently of the moulting process, though covered with a cuticular membrane, until a miniature appendage is formed." "The time required for the renewal of a limb thus depends upon the time at which an injury occurs with reference to the moult, and also upon the physiological condition of the

* *Op. cit.*, p. 85.

† From Herrick's Monograph on the American Lobster, pp. 103, 104.

‡ *Op. cit.*, pp. 104, 105.

animal. If the tips of the large chelipeds are clipped off, autotomy does not always or usually occur, and the limb is completely repaired after one moult." Couch* in this connection said—"I am led to believe that when a limb has been lost at some moderate time previous to exuviation, the restoration is much more rapid and perfect at the next succeeding time of the process than if left to the more ordinary proceeding of nature."

The crab can throw off an injured limb, or it may when seized by a foe, in order to escape—purchase freedom at the voluntary expense of a limb. It is then severed at what is known as the fracture-plane, which is marked externally by a suture, extending round the second or basi-ischiopodite joint. Within the segment there are at this point two closely-applied diaphragms which, except for a small foramen, shut off the short proximal from the longer distal part of the limb. The foramen piercing the two diaphragms gives passage to the nerves and vessels that supply the appendage.† (Plate I., Fig. 7.) The fracture takes place between the two septa, the proximal diaphragm remaining as a covering to the broken second joint, the other going with the cast-off limb. The foramen is immediately closed with a small clot of blood. The edge of the shell and the diaphragm soon turn black; a new skin develops within, and the outer black layer, which is now dead tissue, is gradually rubbed off, exposing the new skin. Within this skin, when the crab is preparing to cast, a new limb is formed, and, as it grows, bulges the external covering out in the form of a bud. The scars which mark the lost limbs are found in many different stages—(1) Immediately the limb is lost the scar is white; (2) then the outer skin (the diaphragm) dies and becomes black—this is accompanied by the formation of a new skin beneath it; (3) the black dead tissue is rubbed off through time, or on the bulging out consequent on the formation of the bud; (4) the live skin, when exposed by the removal of the dead tissue, becomes brown. The formation of a bud soon after the limb is lost, and while the dead tissue still covers the scar, is dependent on the nearness of the casting period.

These conclusions are founded upon the observations made upon the beach crabs during each month for a year. Buds of new limbs were noticed mainly during the casting period—viz., June (4 individuals), July (21 individuals), August (10 individuals), and September (3 individuals). In the case of very small crabs, less than 1 inch across, the papilla which is the rudiment of the new limb has been observed in September, October, December, January, and February; while buds have been noticed in November, December, February, March, May, and July. Two crabs measuring 3 inches and $1\frac{3}{4}$ inches respectively shewed in December and January small papillæ on the scars of lost limbs. The crabs under 1 inch in breadth doubtless cast more than once in the year. The only crab which was found soft on the beach in February was one measuring $\frac{4}{5}$ inch. It had just cast. I have no data bearing upon the time required for the formation of the new limb, but it appears that only in the case of a limb lost some considerable time before casting will regeneration be completed at that time. Thus, a crab measuring $1\frac{3}{8}$ inches across cast in a tank at Dunbar in September. Two of its limbs were missing, and a third was injured. The dactylopodite of one biting claw had been broken off, and the injury was covered by a black scar. The soft crab was without three limbs, and had both chelae perfect. Two soft crabs

* *Op. cit.*, p. 11.

† L. Fredericq gives a detailed description and figures of this part of the limb in *C. pagurus* with reference to the phenomena of autotomy. He describes, however, only one diaphragm, his "membrane obtenatrice" corresponding to the proximal of the two described above. "Nouv. Rech. s. l'autotomie chez le crabe," *Arch. Biol.*, XII., 1892, p. 177 *et seq.*

obtained in August showed small buds of new limbs. These had been evidently present when casting took place. The loss of the limbs had in these cases occurred too soon before casting to enable the new limb to be completely formed.

In adult crabs also, which, from their dirty condition, could not have cast for two or three years, the brown scar on the second joint has been found to be covered with large barnacles, *Anomia*, and zoophytes, which clearly indicated that the renewal of the limb was not a process which was inaugurated immediately on the injury being sustained.

A crab does not always throw off an injured limb. Many crabs are found which have lost the last joint of a limb, viz. the dactylopodite. In these cases a black scar covers the place of injury. Sometimes the muscle is shrunk away from the shell, leaving it to project in front of the black scar. This not unfrequently happens in cases of injury to the last joint of the biting claw. A soft crab showed a rather unusual condition. A limb had been broken off near, but not at, the fracture plane. The shell had grown inwards over the scar, reducing the aperture very much. A female in one of the tanks at Dunbar had received an injury to one of the walking limbs; it had been broken off about the middle of the fifth joint, the propodite. The muscle was decaying; there was no appearance of a scar. Even in this case the crab had not got rid of the injured member.

As to the repair of injuries to the carapace, this seems to be dependent on the activity of the chitinogenous epithelium, and only occurs at the time of casting or while the crab is still soft. When the fishermen are testing the soft crabs in autumn they are more than likely to push the thumb through the shell. The crab is then often thrown into the water, and numerous examples of the repair of the injury have come under my notice. It is not at all difficult to get during the winter, in the catches of the fishermen, some of the crabs which had been thus treated. Some of these show a complete, and others a partial repair of the shell. Old-looking crabs are from time to time captured which show more or less severe injuries to the carapace. In these the parts where the flesh has been exposed are covered simply by a soft black scar, beneath which a thin live skin is found. It is therefore apparent that the renewal of the shell over the injured part does not take place during the whole interval between two castings, but only during the time the dermis is active in thickening the shell, a period of, on the average, four months probably. Again, the chance of repair to the injury will be the greater the sooner it occurs after casting. Even on casting the old injuries are not always completely repaired. The injured area may, in the soft crab, be of less extent, but cases have been noticed where soft crabs showed injuries which had evidently been present before casting. In such cases it has probably happened that the chitinogenous epithelium had at that part been destroyed, and at the time of casting it had not been completely renewed by the ingrowth of the epithelium surrounding it.

The regeneration of the limbs only takes place when the crab is *preparing* to cast. The repair of injuries to the carapace only takes place at the same period, or during the time the crab is soft. The presence of buds of new limbs may be regarded as an indication that it is about to cast.

In the case of adult crabs the new limb cannot reach the size of the other limbs until after at least two moults. Crabs which have diminutive chelae are not uncommon.

Rate of Growth and Distribution.

With the view of arriving at some determination of the rate of growth of the crab, the method which has been used by Petersen in connection

with the rate of growth of the plaice has been applied to a considerable number of crab measurements. The method consists in regarding the peaks which appear in the curve plotted from the measurements of a large number of individuals as marking the modal size, at intervals of one year. If, then, in a curve made from the measurements of crabs, distinct peaks were found, we should probably be entitled to look upon such intervals as approximately representing the average increase in the size of the crab following casting. The increase in size varies with the size of the crab. All the crabs have been measured across the greatest breadth of the carapace. Crabs were got from two sources—(1) 2336 crabs (1153 males and 1183 females) collected between tide-marks on the beach; (2) 3029 crabs (1507 males and 1522 females) caught in the creels of the fishermen. The beach crabs * were measured in centimetres (Table VIII), and the curves plotted from the measurements are to be found on Plate II. The curve for the males is black; that for the females red. It is at once seen that the curves of the two sexes, although each very irregular, follow one another closely. The irregularity of the curves indicates great variation in growth. Between the sizes 1·7cm. and 7cm., male and female crabs were found at every half-millimetre, except in the following cases. Females were not obtained at the following sizes—1·85, 5·45, 6·05, 6·25cm., and males were not observed at 5·55, 5·95, 6·05, and 6·65cm. Since the crab does not increase in size gradually, but by leaps, the irregularity in growth is by the preceding facts rendered very apparent. Until the rate of increase in size at each moult is determined, it is not possible to interpret curves such as we have in the present case. The curves of the creel crabs (Plate III.) also show great variation in growth. These crabs were measured in eighths of an inch; their curves are shown as dotted black and red lines. In order to admit of a comparison between the beach and creel crabs, the curves of the former have been converted to a one-eighth-inch basis, and are shown alongside the curves of the adult crabs. On reference to the former curves it is seen that the great majority of the beach crabs are between $\frac{7}{8}$in. and 2$\frac{1}{4}$in. in breadth. There are very few crabs below $\frac{7}{8}$in. We, however, know that they must exist in even greater numbers than the larger crabs, and the reason for their non-appearance in the lists is probably simply their absence from that region. It is no doubt the case that these small crabs are more likely to be overlooked during their collection on the beach, but a crab of even half-an-inch in breadth is by no means inconspicuous. I am of the opinion that the majority of the crabs in the stages less than $\frac{7}{8}$in. do not make the beach their habitat. The beach crabs were almost without exception found beneath stones which were left dry by the ebb; they were usually buried as deep as the edge of the carapace in a mixture of mud and sand. Very rarely were any found where the bottom consisted of rough gravel, into which they could not burrow. A look-out was kept specially for the very small crabs, and the non-success in finding them is no doubt due to the fact that they do not come within tide-marks. While we may occasionally get there crabs about 3in. across, still from $\frac{7}{8}$in. to 2$\frac{1}{4}$in. may be taken as the description of the beach group. With regard to the creel crabs, the measurements of which are detailed in Table IX., it is seen from the curves that very few measure less than 4in. across. The dates of the ten catches which were measured are —December 20, 1897; January 28, February 25, March 31, May 3, May 27, November 5, 1898; June 3, July 12, August 4, 1899. Of the 3029 crabs, 2887, that is 95 per cent., are above 4in. in breadth. The smallest crabs in the catches are two measuring respectively 2$\frac{5}{8}$in. and 3in.

* For the dates of collection see Table IV., p. 101.

They were caught on July 12, when the creels were shot close inshore near low-water mark. The next smallest, viz. two at 3¼in. and 3⅜in. respectively, were caught in November in 24 fathoms. The fishermen agree in saying that they never get any crabs smaller than 3in. across offshore; but that such crabs are often seen when the creels are shot in summer near low-water mark. They are, however, able to escape through the meshes of the net covering the creel. These crabs may be seen in the pools at the edge of the tide during big ebbs. The curves of the beach and creel crabs only overlap very slightly; in fact they may be said to be quite distinct. Now, it is impossible that the crabs in the beach group could by one casting enter the creel group of crabs. There is a very large gap between the two, which must be filled by another group of crabs which is not represented, except by one or two examples. This group is to be found neither on the beach nor in the creels, except when they are shot close inshore. There is every probability that these crabs, which may for convenience be labelled the 2½ to 4 inches group, will be found just outside low-water mark, and this is rendered the more probable since certain members of the group appear among the beach crabs and occasionally with the creel crabs. They are littoral, but they do not appear to allow themselves to be left dry at low water. In the Report of the Crab and Lobster Commission, Mr Roach, a witness, said he has been to a place behind the breakwater (Plymouth) every year, and caught small crabs, but no large ones; therefore concludes that the small crabs are a distinct species: he thinks the place a nursery for them" (p. 56). To complete the cycle, then, there are two groups wanting—viz., Group I. from the *Megalopa* stage to the crab of one inch across, and Group III., those from 2½ to 4 inches in size.

The distribution of the crab may then be tentatively described as follows:—Group I., the postlarval stages and earliest young stages up to ⅞-inch in breadth, which is probably restricted to the shallow shore waters where it was hatched; Group II., the beach crabs, from ⅞ to 2¼ inches, which are to be found between tide-marks, usually left dry by the ebb; Groups III., the crabs from 2½ to 4 inches, which appear to be confined to the littoral waters just outside low-water mark; Group IV., crabs of 4 inches and upwards, which may be termed the mature group, and which are to be found in winter offshore beyond the twenty fathom line, and in spring and summer in the inshore waters sometimes even within tide-marks. The sizes which have been given to the groups are only intended as approximate. It is very unlikely that the various groups are separated sharply.

As to the age at which a crab becomes mature, I can furnish no data. That can only be determined when it is known how often a crab casts before it arrives at a size of 4 inches, and also how often the young crabs may cast each year. These facts, and the rate of increase at each cast, remain to be discovered.

The irregularity in the rate of growth may be due to two factors—(1) a difference in size between individuals in the same larval stages, which difference would be perpetuated, and probably increased, with each moult; and (2) the possibility of more frequent casting in the case of certain individuals during the early stages. The moulting is probably directly due to the supply of food, and this is no doubt subject to considerable variation in the case of different individuals.

A general description of the life-history of the crab may be here proposed. It rests directly on the conclusions come to above with regard to Groups I. and III., and remains or falls with the future proof of their reliability or error. The crab hatched in the inshore waters, when it

reaches a size of about one inch, passes into the beach-group; when it has grown to a size of 2½ inches it leaves the beach for the littoral waters just beyond low-water mark, stony or rocky ground; on arriving at a size of 4 inches it joins the mature group and takes part in the great seasonal migrations. In support of the probability that the crabs of different sizes are restricted to more or less fixed habitats, one has only to consider that, except for this distribution, the crab occupies the same position in the economy of the sea during its whole life. It is a bottom-feeder, and it is apparent that the small crabs would be extremely liable to become the prey of their larger brethren if they occupied the same habitat. And from the fact that the crabs of Groups I. and III. are to be occasionally found with Group II. on the beach, it is very probable that the habitats of the three groups are contiguous. The mature Group IV. gives rise to the crab-fishing.

[TABLE.

Table VIII.

Measurements of the Beach Crabs in Centimetres.

The Hard and Soft Crabs are taken together.

Cm.	Inches.	Male.	Female.	Male + Female.	Cm.	Inches.	Male.	Female.	Male + Female.	Cm.	Inches.	Male.	Female.	Male + Female.	Cm.	Inches.	Male.	Female.	Male + Female.
·5	-	-	-	-	3·1	-	31	*30*	61	5·7	2¼	19	*14*	33	8·3	-	-	*1*	1
·66	¼	-	*1*	1	·2	1¼	21	*34*	55	·8	-	13	*10*	23	·4	-	-	*1*	1
·7	-	-	-	-	·3	-	40	*33*	73	·9	-	14	*9*	23	·5	-	2	*2*	4
·8	-	-	-	-	·4	-	21	*29*	50	6	2½	10	*11*	21	·6	3½	-	-	-
·96	⅜	1	-	1	·5	1½	27	*32*	59	·1	-	13	*17*	30	·7	-	-	*1*	1
1	-	-	*1*	1	·6	-	27	*35*	62	·2	-	9	*4*	13	·8	-	-	*1*	1
·1	-	1	*1*	2	·7	-	42	*33*	75	·3	2½	9	*7*	16	·9	3½	-	*1*	1
·2	-	1	*5*	6	·8	1½	38	*28*	66	·4	-	5	*5*	10	9	-	-	*2*	2
·3	¼	5	*1*	6	·9	-	36	*22*	58	·5	-	7	*14*	21	·1	-	-	*2*	2
·4	-	15	*10*	25	4	-	32	*35*	67	·6	-	1	*6*	7	·2	3½	-	-	-
·5	-	20	*11*	31	·1	1½	43	*28*	71	·7	2½	4	*7*	11	·3	-	2	*1*	3
·6	⅜	12	*12*	24	·2	-	32	*36*	68	·8	-	11	*6*	17	·4	-	-	*2*	2
·7	-	16	*11*	27	·3	-	29	*32*	61	·9	-	4	*4*	8	·5	3½	-	-	-
·8	-	14	*7*	21	·4	1¾	28	*27*	55	7	2¾	3	*10*	13	·6	-	-	*1*	1
·9	⅜	5	*10*	15	·5	-	30	*30*	60	·1	-	7	*8*	15	·7	-	-	-	-
2	-	10	*18*	28	·6	-	22	*31*	53	·2	-	6	*6*	12	·8	3¾	-	*1*	1
·1	-	13	*10*	23	·7	-	22	*36*	58	·3	2¾	2	*1*	3	·9	-	-	*2*	2
·2	½	12	*12*	24	·8	1¾	26	*20*	46	·4	-	3	*2*	5	10	-	-	*1*	1
·3	-	24	*21*	45	·9	-	17	*23*	40	·5	-	2	*2*	4	·1	-	-	-	-
·4	-	21	*19*	40	5	-	21	*24*	45	·6	3	2	*1*	3	·2	4	-	-	-
·5	1	21	*23*	44	·1	2	16	*32*	48	·7	-	-	-	-	·3	-	-	-	-
·6	-	27	*17*	44	·2	-	12	*21*	33	·8	-	2	*3*	5	·4	-	-	-	-
·7	-	26	*19*	45	·3	-	18	*17*	35	·9	3¼	1	*2*	3	·5	4¼	-	-	-
·8	1¼	27	*24*	51	·4	2¼	13	*11*	24	8	-	1	*1*	2	·6	-	-	-	-
·9	-	23	*23*	46	·5	-	13	*17*	30	·1	-	-	*4*	4	·7	-	-	-	-
3	-	31	*38*	69	·6	-	18	*17*	35	·2	3½	-	*3*	3	·8	4¼	1	-	1
Total,		325	*294*	619	Total,		675	*713*	1388	Total,		148	*157*	305	Total,		5	*19*	24

Total, - {Males, 1153 / Females, 1183} - - 2336 Crabs.

Table VIIIa.

Beach Crabs measured in Inches.

The Hard and Soft Crabs are taken together.

Size.		Hard and Soft Crabs.			Size.		Hard and Soft Crabs.			Size.		Hard and Soft Crabs.		
Inches.	Cm.	Male.	Female.	Male + Female.	Inches.	Cm.	Male.	Female.	Male + Female.	Inches.	Cm.	Male.	Female.	Male + Female.
1/4	·65	-	*1*	1	1 1/8	4·1	104	*96*	200	3	7·6	4	*4*	8
3/8	·95	3	*7*	10	3/4	4·4	102	*124*	226	1/8	7·9	2	*7*	9
1/2	1·3	40	*22*	62	7/8	4·8	64	*67*	131	1/4	8·2	2	*7*	9
5/8	1·6	42	*30*	72	2	5·1	46	*70*	116	3/8	8·6	-	*2*	2
3/4	1·9	28	*38*	66	1/8	5·4	44	*45*	89	1/2	8·9	-	*5*	5
7/8	2·2	57	*52*	109	1/4	5·7	46	*33*	79	5/8	9·2	2	*3*	5
1	2·5	74	*59*	133	3/8	6·0	32	*32*	64	3/4	9·5	-	*1*	1
1/8	2·8	112	*115*	227	1/2	6·3	22	*32*	54	7/8	9·8	-	*4*	4
1/4	3·2	82	*96*	178	5/8	6·7	19	*17*	36	4	10·2	-	-	-
3/8	3·5	96	*100*	196	3/4	7·0	16	*24*	40	1/8	10·5	-	-	-
1/2	3·8	106	*85*	191	7/8	7·3	7	*5*	12	1/4	10·8	1	-	1

Table IX.

Measurements of Crabs—*10 Catches. Dec. 1897 to Aug. 1899.*

Size.		Hard and Soft Crabs.			Size.		Hard and Soft Crabs.		
Inches.	Cm.	Male.	Female.	Male + Female.	Inches.	Cm.	Male.	Female.	Male + Female.
2¾	6·7		*1*	1	5¼	13·3	84	*87*	171
¾	7	-	-	-	⅜	13·6	83	*60*	143
⅞	7·3		-	-	½	14·0	90	*112*	202
3	7·6	-	*1*	1	⅝	14·3	64	*77*	141
⅛	7·9	-	-	-	¾	14·6	65	*77*	142
¼	8·2	1	-	1	⅞	14·9	43	*60*	103
⅜	8·6	1	*1*	2	6	15·2	46	*54*	100
½	8·9	8	*8*	16	⅛	15·5	42	*39*	81
⅝	9·2	11	*13*	24	¼	15·9	17	*31*	48
¾	9·5	24	*15*	39	⅜	16·2	17	*35*	52
⅞	9·8	29	*29*	58	½	16·5	29	*24*	53
4	10·2	36	*35*	71	⅝	16·8	17	*13*	30
⅛	10·5	70	*62*	132	¾	17·1	11	*20*	31
¼	10·8	79	*72*	151	⅞	17·5	6	*5*	11
⅜	11·1	76	*64*	140	7	17·8	4	*12*	16
½	11·4	91	*78*	169	⅛	18·1	2	*3*	5
⅝	11·7	76	*61*	137	¼	18·4	2	*4*	6
¾	12·1	103	*95*	198	⅜	18·7	1	*1*	2
⅞	12·3	81	*77*	158	½	19·0	2	*1*	3
5	12·7	120	*109*	229	⅝	19·4	-	-	-
¼	13·0	75	*86*	161	¾	19·7	1	-	1
Total,		881	*807*	1688	Total,		626	*715*	1341

Total—Hard and Soft Crabs, { Male, 1507 / Female, 1522 } - - 3029 Crabs.

The Migrations of Crabs.

That the adult crabs undertake definite seasonal migrations—viz., in the spring to the shallow shore waters, and in autumn to the deeper offshore areas—has been long known to fishermen During the enquiry held in Scotland by the Crab and Lobster Commission of 1876, Mr. George Findlay, of Whitehills, Banff, exhibited a chart of the sea-bottom adjacent to Banff, Macduff, and Whitehills, showing that in the autumn months the crabs are three miles from land, and in the summer months, May to August, near the land for shelling.*

With a view to arriving at more definite data regarding these migrations, a considerable number of crabs, 1567 were labelled and set free in the sea near Dunbar. Of that number 876 were put away at the mouth of the harbour,† and 691 at various distances from ½ to 3½ miles off

* Report of the crab and Lobster Commission, 1877, p. 18.

†The Crabs were labelled under the supervision of the writer, or of Mr. Hutchison, Dunbar. They were then taken to sea by a fisherman who had instructions where to set them free.

shore. Of these crabs, 131, that is 8 per cent., have been recaptured. There are certain circumstances which tend to lower the number of the crabs which may be recaptured, viz. (1) the chance of the label being torn off; (2) the risk of death following the treatment to which the crab is exposed while being brought ashore, labelled, and returned to the water. The percentage of recovered crabs is very much lowered by the very few crabs recaptured during the first part of the experiment. Of 539 crabs labelled from October 1897 to April 1898, only 12 were recaptured. Of 1028 labelled since November 1898, 119 have been recovered, viz. 11·5 per cent. The crabs were marked by attaching, by means of a silver wire, a nickel label, about ½ to ¾ inch square, to a small hole bored in the edge of the shell, usually at the seventh septum on the left side. At first small brass labels were used; some of these were attached by fine brass snare wire to the great claw, others were attached in the same manner as the nickel labels. Two only were recovered with the label tied to the claw. Nickel labels were alone used for the crabs labelled from 1 to 1173. The number of crabs set free at one time, the date, and the place are given in Tables X. and XI. On the right side of the Table the particulars regarding the recaptured specimens, their condition when set free, and when and where recovered, the length of the interval of freedom, etc., and in a number of cases the sex and size of the crab, are detailed. Table X. contains the crabs put away at the mouth of the harbour; Table XI., those returned to the sea at various distances from shore.

The majority of the crabs used for labelling were soft gauge crabs, in number 999; 568 hard crabs, viz. 532 small crabs measuring 3¼ to 4¼, and 36 gauge crabs, were also marked. The small hard crabs were used for labelling from January to July; the large hard crabs in June and July; the soft crabs from July to December. Of nine batches, consisting of 333 marked specimens, no individual was recovered. The date and other particulars of these lots are given in the following Table.

Date.	Number of Specimens.	Description.	Mode of Attachment of Label.	Place where set free.
Oct. 29, 1897,	52	Soft,	Attached to great claw,	Mouth of harbour.
Nov. 1, ,,	51	,,	,, ,, ,,	,, ,,
Dec. 2, ,,	19	,,	,, ,, ,,	,, ,,
,, 24, ,,	35	,,	,, to edge of shell,	,, ,,
,, ,, ,,	19	*u. Hard	,, ,, ,,	,, ,,
Feb. 26, 1898,	22	,,	,, ,, ,,	4 miles N. of Dunbar.
Mar. 1, ,,	35	,,	,, ,, ,,	,, ,,
May 13, 1899,	50	,,	,, ,, ,,	3 miles E. by N. of Dunbar.
,, 25, ,,	50	,,	,, ,, ,,	Mouth of harbour.

* Under gauge size.

Very few small hard crabs were recovered, viz. 16 only out of a total of 532. This was in some measure no doubt due to the fact that the

majority, if not all, of the small crabs cast during the summer. Certain soft crabs came under my notice which had evidently been labelled, for they showed a gap torn in the edge of the carapace at the part where the label was usually attached. None of the small hard crabs were recovered later in the year than September, that is to say later than the casting period; one was captured in August, a second in September. One apparent exception to the statement is the crab No. 8 in Table XI. It had, however, been free only fourteen days when it was captured in November. The probability, then, is that casting accounts partly for the non-recovery of the small crabs.

In the Tables, in addition to the distance and direction from Dunbar of the place where each labelled crab was retaken, the depth of the water at the spot is also given. The fishermen, although able to give only very approximate particulars of distance and direction, can give within small limits the exact depth at which their creels are fishing. The direction from Dunbar and the depth of water are surer guides to the locality of capture than the distance as estimated by them.

In order to show graphically the results of the experiments, the places where the crabs have been recovered have been marked on a chart of the sea near Dunbar (Plate IV.). Two marks, each of two different colours, are employed to distinguish the different groups of crabs. Thus the black marks relate to those crabs which were recaptured in the months of August to February inclusive; the red colour designates the crabs caught in the period April to July inclusive. No crab was recaptured in March. The little discs (red and black) denote crabs which were set free at the mouth of the harbour (Table X.); the crosses (red and black) refer to crabs which were set free at some distance from Dunbar (Table XI.).

The chart, Plate IV., first of all shows that the labelled crabs caught from August to February were, with two exceptions, all got out in 18 to 25 fathoms water, while those caught in April to July were got in an average of 8 fathoms. Of the winter crabs, 101 in number, 89 were found in water of over 20 fathoms in depth, ten in 18 to 19 fathoms, one in 17, and one in 16 fathoms. The depth, then, for these crabs was 18 to 30 fathoms. Of the 27 summer specimens, 19 were found in 4 to 8 fathoms, three in 10, three in 13, and one in 16 fathoms. The crabs recaptured in the months August to February will be first discussed. If now we consider the crabs set free at the mouth of the harbour (Table X.), and represented in the chart by a disc, we see that they were mainly recaptured between a northerly and north-easterly direction from Dunbar; and from the fact that three specimens, Nos. 28, 29, and 30, which had been free for two days only, had travelled from the harbour 2 miles and 2½ miles respectively in a north-easterly direction, it is very probable that the massing of these crabs just beyond the twenty-fathom line, and in an area bearing N.E. from Dunbar, points to the crabs having gone out in that direction. The crab which had travelled farthest, No. 40, was found 6 miles to the north of Dunbar after 59 days. While the majority, then, had apparently moved off to deep water in a north to easterly direction, three had taken an easterly and three an east by south course. The results then point to a definite direction, viz. N.E., taken by the crabs in going from the shallow water at the mouth of the harbour out to the ground beyond the twenty-fathom line.

Most of the crabs which were put away at some distance from Dunbar were set free from 1 to 3 miles in an E. by N. direction. Two lots, numbering 30 and 26 individuals, were liberated at 1½ miles and 2 miles respectively east of the harbour, and a third lot,

51 crabs, about 2 miles S. E. Of those set free in an E. by N. direction, 32 were found to the north of the place of liberation, that is to say they had moved along in about the same depth of water; 14 were to the south of the same; two which were set free one mile from shore were got one mile further east; while three, after intervals of freedom of 24, 26, and 83 days, were found close to where they were put away. The latter were set free—in August, two crabs, and in October one crab, out beyond the twenty-fathom line. One crab, No. 46, Table XI., was found to have travelled in 54 days to a point 8 miles from the place of liberation.* Of the crabs captured from April to July, 14 had been set free at the mouth of the harbour, and 13 offshore. Of the former, four were found near the harbour; two of these had been liberated in December, the third in April, and the fourth in June. Four which were taken at $1\frac{1}{4}$ miles N.W. (two specimens), 2 miles west (one specimen), and $1\frac{1}{2}$ miles S.E. (one specimen), had been set free in November. Two set free in January were recaptured $1\frac{1}{2}$ miles E. and $\frac{3}{4}$-mile E.S.E. of Dunbar respectively. Nine of the crabs set free offshore were found in the summer months to the south of the place where they were liberated. No. 6 (Table XI.) was, according to the report of the fishermen, got 3 miles east by south, at which place a depth of 20 fathoms is found. This was in April, at which time, I am informed, no boat is fishing in water of that depth.

It has several times happened that two crabs which were liberated together were recaptured on the same day after intervals of 9 to 122 days, and although in certain cases they have been found near one another, it has oftener happened that the places of capture were at some distance apart. One striking case is that of Nos. 11, 12, and 13, Table X, which were captured on April 19th, after an interval of freedom of 165 days. Two were got near together; the third was about 3 miles distant from the others. All the lots of crabs, with one exception, show simply a migration in one direction, which in the majority of cases is seaward, in a few cases shoreward. The exception is a collection of crabs which was set free at the mouth of the harbour in November, Nos. 6 to 14, Table X. Of these, five were recaptured during December, January, and February, at from 2 to $3\frac{1}{2}$ miles offshore. In April three were obtained close inshore in 8 fathoms, and in May a fourth was found in 7 fathoms. There is very little doubt but that the last four crabs had in November gone off to deep water with the others, and had returned in April and May to the shallows. With regard to the months in which they take place, we are able to fix the migrations within certain limits. When the take of crabs diminishes in June, the majority of the boats bring their creels ashore and prepare for the summer herring fishing, or begin line fishing. They return to the crab fishing in the middle of September or beginning of the following month, according to the bad or good result of the herring fishing. When they do so, they shoot their creels right out in deep water. The few boats which continue fishing in July and August do so close inshore, and the main portion of the catch consists of females which have just hatched their eggs. In August a considerable number of comparatively small soft crabs are also got (*see* p. 106). Many of the large crabs which have come near the land in April and May cast inshore, and move out to sea again. In order to find what crabs were offshore in August, I arranged to have ten creels shot 3 miles N.E. of Dunbar, at which place 18 fathoms were found.† Ten crabs were obtained—viz., four large hard females $6\frac{5}{16}$ to $6\frac{3}{4}$ inches across, three of which had just hatched their eggs, four small males $4\frac{1}{16}$ to

* After going to press, a crab (No. 49, Table XI.) has been got in St. Andrews Bay; it has in seven months travelled across the Firth of Forth to a point 18 miles north of the place where it was set free.

† There is here a discrepancy between the distance from shore and the depth. The distance or direction, judging from the chart, is probably at fault.

$4\frac{5}{8}$ inches, and one small hard female $3\frac{3}{8}$ inches across. Not a single soft crab was obtained. The probability is that the soft crabs had not yet migrated, but the large hard females captured on this occasion had done so; since there is little doubt but that the berried females come inshore, and the eggs hatch there in summer, July being probably the principal month. By the middle of September (13th) 1899, the soft crabs were got in great numbers in 25 fathoms. The migration of the soft crabs appeared, then, to have begun last year (1899) between the middle of August and the middle of September. The experiment described above gives some ground for the conclusion also that the large females which had lately been berried, and which are not about to cast, migrate soon after the hatching of the eggs. From the labelling experiments some little evidence is thrown upon the migration of the large hard males. A number of large male crabs were labelled and set free at the mouth of the harbour in June. On July 14th one of these, No. 19, Table X., was got close to the harbour; in September another, No. 20, was taken in a creel 2 miles N.E. in 22 fathoms, and in October two more were captured; one, No. 21, 2 miles N.E. in 22 fathoms, and the other, No. 22, $1\frac{1}{2}$ miles E. by S. in 18 fathoms. A large hard male crab, set free at the harbour in July, was found in December, 3 miles N. E. in 22 fathoms. We may probably conclude, then, that these large males had not begun to migrate in July, and by September they had done so. The migration seaward of hard and soft crabs then probably occurs during August and September. The statistics which were kept during the last four months of last year of the hard and soft crabs captured daily point to a migration of crabs less than $4\frac{1}{4}$ inches across the back taking place a little later than that of the gauge crabs. In Table XII. it is seen that up till September 29th, although there were a great number of soft gauge crabs, there was none under $4\frac{1}{4}$ inches. After that date the number of small crabs increased rapidly.

The inshore migration appears to begin usually in February. In February and March the creels are still shot in deep water, and also sometimes in shallow water. In these months the men begin to shift the creels in, but up to the end of March 1898 some of the boats were still fishing in 18 fathoms, while others were working in 8 fathoms in February. The inshore migration appears to be more irregular than its seaward counterpart. By April and May the crabs are usually close inshore. In May 1898, however, the men had to shift their creels to about a mile offshore, where there is a depth of about 14 fathoms, owing to the scarcity of the crabs inshore. It is very evident that the inshore migration is subject to considerable fluctuations. It moreover seems to be very gradual, thus differing from the seaward migration, which is apparently very rapid. Thus, three crabs which were set free at the harbour on Saturday, September 23rd, were captured on the following Monday, September 25th—one at 2 miles, the other two at $2\frac{1}{2}$ miles N.E. of Dunbar. The creels had been shot on Saturday and remained in the water till Monday. The crabs had thus travelled $2\frac{1}{2}$ miles in two days. The time taken to the journey was possibly less. The inshore migration has a very important effect on the crab fishery, for during April and May the concentration of the crabs in the shallow water of necessity restricts the fishing area, and intensifies the fishing capacity of the creel. At this time of the year the largest number of creels is employed, certain boats having as many as 200, while no boat will have less than 100. There are probably at least 3000 creels shot each day during these months. The catch is at this time the greatest. By June the takes diminish rapidly. While this fact may be in part due to the crabs retiring to cast, it is

very possibly simply in consequence of the crabs being nearly all fished up. The explanation given by the fishermen is that the crabs "hole up," or "do not creep." The fact of the double migration of the crab is not accepted by all the fishermen. They are of the opinion that there are certain "bodies" of crabs restricted to deep water and other bodies to shallow water. And since during the winter they get no crabs inshore, the reason is that the inshore crabs "hole up" in winter; and since in summer no crabs are got off in deep water, it is owing to their retiral to their burrows, from which they cannot be tempted by the ordinary baits. A generally accepted belief is that crabs will not "creep" all the year round. These are merely attempts to account for the phenomena of migration. Another difficulty, which gives rise to the view that there are varieties of crabs restricted to special areas, is due to the fact that the appearance of the crab changes with the season. As the shell of the crab grows older it darkens, becomes yellow underneath; and its general appearance is affected by the ectozoa which attach themselves to it.

What, then, are the causes of the migrations of the crab? The reason for the migrations may be sought for in two directions—(1) the influence of temperature; (2) the necessity for food. The time in the crab's life when temperature will most probably affect it is (1) during the incubation of the egg; (2) during the process of casting. From the appended Table of temperatures of the bottom water of the sea at Dunbar, taken in June, July, and August, 1899, by a fisherman, it is seen that with one insignificant exception the water at 6 to 8½ fathoms was much warmer than the water offshore in 21 to 25 fathoms. During that period the eggs hatch, and as we know that warmth has the effect of hastening the development of the ovum, we may conclude that in the case of the berried crabs the migration shoreward aids the hatching of the eggs. Berried crabs extrude their eggs offshore in winter, when the bottom water is warmer than that near the shore; their presence inshore in summer pre-supposes a migration thither. Secondly, there is every ground for holding that the soft crabs cast in the shallow inshore water; the warmth possibly influences favourably this process.

Temperature of Water at Bottom.

Date.	Three Miles from Land.			Half Mile from Land.			Just outside Harbour.		
	Temperature.	Depth.	Time.	Temperature.	Depth.	Time.	Temperature.	Depth.	Time.
1899.	*Degrees.* C.	*Fathoms.*		*Degrees.* C.	*Fathoms.*		*Degrees.* C.	*Fathoms.*	
June 8	7·5	25	12.45 p.m	8	13	1.30 p.m.	9	6½	2.10 p.m.
,, 15	8	25	4.30 ,,	9	12	2.45 ,,	11	7½	2.0 ,,
,, 23	8	25½	1.40 ,,	9	13	11.50 a.m.	10	8	11.30 a.m.
,, 30	8·5	25	5.30 ,,	9·5	12½	3.15 p.m.	11·5	6½	2.30 p.m.
July 6	8·5	25	5.15 ,,	10	13	3.10 ,,	12	6½	2.45 ,,
,, 14	9·9 (10)	22	12 noon.	11·3	13	1.5 ,,	11·9	7	1.15 ,,
,, 21	9·5	24	4.30 p.m	10	18	5.15 ,,	.	.	.
Aug. 2	11	23	6.30 ,,	12·5	12½	7.0 ,,	13	8	7.10 ,,
,, 11	13	21	7.0 ,,	12·5	13	7.30 ,,	12·8	8½	7.45 ,,
,, 18	13	22	8.0 ,,	14·5	14½	8.30 ,,	15	7½	8.45 ,,
,, 25	13	22	7.15 ,,	15	14	8.0 ,,	15·5	6½	8.20 ,,
Se . 25	11·9	25	12.15 ,,	11·6	10	3.0 ,,	.	.	.

The migration offshore in August and September cannot, however, be explained by reference to temperature. At the end of August last year, at which time the soft crabs were probably making their way seawards, the temperature of the inshore water was still higher than that of the deep water, and on September 25th the temperature at 10 fathoms was only ·3 of a degree less than that at 25 fathoms. Moreover, small soft crabs are to be found between tide-marks on the beach all through the winter (*vide* Table IV.). It is not at all likely that the adult soft crabs would be inconvenienced by cold when the small crabs are not affected by it. The migration of the soft crab may with some reason be attributed to the necessity for food. Immediately after casting the crab feeds ravenously, and it is therefore not unlikely the shore waters may not offer them a sufficient food supply. It is not improbable that the inshore migration may also be due to a search for food. Both migrations appear to be shared by male crabs which are not about to cast. The offshore ground upon which the crabs are found in winter appears from the chart to consist of sand, with stony patches here and there, while further to sea the bottom is of mud. About 600,000 crabs are taken each year at Dunbar, and although the length of the fishing ground is considerable, probably 14 miles, its breadth will not exceed about 4 miles. The amount of food which these crabs consume must be great indeed. The crab fishing consists in simply setting a barrier of creels in front of, or in the midst of, the migrating crabs, and as the crabs move along the creels keep pace with them.

Mr. Hutchison, Dunbar, has informed me that certain fishermen at Skateraw had been accustomed to bring the soft crabs which they caught in deep water during winter to the shore in order to set them at liberty in shallow water. They did so with the view of stocking the shore waters for the summer fishing. It is very doubtful if any of these transported crabs remained inshore; they probably immediately moved right off to deep water, just as did the labelled soft crabs put away in September, October, and November.

There is evidence that long-continued frosty weather tends to diminish the catch of crabs; the cold is said to make the crabs "hole up." Similar evidence was given before Buckland.

Migration Experiments at Berwick-on-Tweed and Beadnell, Northumberland.

By the courteous permission of the Northumberland Sea Fisheries Committee, their fishery officer, Mr. Buglass, labelled 100 crabs and set them free off Berwick-on-Tweed in February and May 1898. The majority were undersized, and none were recovered.

Mr. Douglas, Beadnell, also kindly labelled 100 crabs, and of these 5 were recaptured.

Date of Liberation.	Place.	Date of Recapture.	Place.	Direction of Migration.
1898.				
1. March 1	.	March 22	.	1½ miles shoreward.
2. Feb. 26	At the Haven.	May 31	Off N. Sunderland, 8 fms.	N.E.
3. ,, 21	4 miles offshore, 26 fathoms.	June 3	Close inshore, 4 fathoms.	4 miles shoreward.
4. March 8	4 miles offshore, 26 fathoms.	,, 17	Close to rocks, 4 fathoms.	,, ,,
5. Feb. 25	4½ miles offshore.	July 9	Close to rocks, 3 fathoms.	4½ ,, ,,

These five crabs are valuable additions to the material supplied by the Dunbar specimens, illustrating, as they so well do, the shoreward migration in spring and summer. The first crab fills a gap which exists in the Dunbar list, since at Dunbar no crab was recaptured in March.

TABLE X.—LIST OF LABELLED CRABS SET FREE AT THE MOUTH OF THE HARBOUR, DUNBAR.

S stands for Soft (not Marketable). H stands for Hard (Marketable). H indicates that the Crab is nearly, though not quite, hard enough to be Marketable.
u indicates a Crab of under gauge size.

Set Free.				Recaptured.								
	Number of Individuals.	Numbers on the Labels.	Date.	Label Number.	Date.	Place.		Condition when Set Free.	Interval of Freedom. Days.	Condition when Re-captured.	Size in Inches.	Sex.
						Distance and Direction from Dunbar.	Depth in Fathoms.					
1	85	—	Oct. 20, 1897	–	Feb. 25, 1898	1 mile N.	14	S	128	H	–	–
2	–	—	—	–	April 15, ,,	2¾ miles N.W.	5–6	S	177	H	–	–
3	45	2002–2046	Dec. 17, ,,	2014	July 1, ,,	Close to Harbour.	–	uH	196	H	–	–
4	–	—	—	2033	July 12, ,,	,,	–	uH	207	H	–	–
5	18	—	April 23, 1898	3640	May 13, ,,	Off Harbour.	8	uH	20	H	–	–
6	96	0–100	Nov. 5, ,,	58	Dec. 2, ,,	3½ miles N.E.	26	uS	27	S	–	–
7	–	—	—	40	Dec. 17, ,,	2½ miles E.	20	S	42	S	–	–
8	–	—	—	19	Dec. 29, ,,	3 miles N.E.	22	S	54	H	–	–
9	–	—	—	62	Jan. 7, 1899	3½ miles N.E.	23	S	63	H	–	–
10	–	—	—	70	Feb. 10, ,,	2 miles E. by N.	18	S	97	H	–	–
11	–	—	—	26	April 19, ,,	1½ miles S.E.	8	S	165	H	–	–
12	–	—	—	63	,, ,,	1½ miles N.W.	8	S	165	H	–	–

13	-		—	65	,, ,,	,,	8	S	165	H	-	-
14	-	—	—	12	May 8, ,,	2 miles W.	7	S	184	H	5 1/16	Male.
15	50	332-381	Jan. 26, 1899	353	Feb. 10, ,,	3 miles NE.	20	uH	15	H	-	-
16	-	—	—	333	May 10, ,,	1½ miles E.	10	uH	104	H	-	-
17	-	—	—	341	May 18, ,,	¾ mile E.S.E.	7	uH	112	H	-	-
18	56	476-531	April 12, ,,	524	Sept. 28, ,,	2 miles N.E.	22	uH	169	H	-	Female.
19	40	651-690	June 23, ,,	662	July 14, ,,	Close to Harbour.	-	H	21	H	-	Male.
20	-	—	—	670	Sept. 29, ,,	2 miles N.E.	22	H	98	H	-	,,
21	-	—	—	667	Oct. 23, ,,	,,	,,	H	122	H*	5 3/8	,,
22	-	—	—	673	,, ,,	1½ miles E. by S.	18	H	122	H	5 5/8	,,
23	34	745-778	July 15, ,,	749	Oct. 26, ,,	5½ miles N.	18	S	103	H	4 7/8	,,
24	-	—	—	770	Dec. 12, ,,	3 miles N.E.	22	H	150	H	6 1/16	,,
25	48	780-827	Aug. 12, ,,	810	Oct. 10, ,,	3 miles N.N.E.	25	S	59	H	-	-
26	-	—	—	826	Nov. 2, ,,	2 miles N.N.E.	19	S	82	H	5	Male.
27	-	—	—	820	Dec. 9, ,,	2½ miles N.	22	S	119	H	4 1/2	,,
28	76	880-956	Sept. 23, ,,	948	Sept. 25, ,,	2 miles N.E.	,,	S	2	S	-	-
29	-	—	—	954	,, ,,	,,	,,	S	2	S	-	-
30	-	—	—	946	,, ,,	2½ miles N.E.	25	S	2	S	-	-
31	-	—	—	951	Sept. 28, ,,	2½ miles E.	20	S	5	S	-	-
32	-	—	—	956	Sept. 29, ,,	2 miles N.E.	22	S	6	S	-	-
33	-	—	—	917	Oct. 7, ,,	,,	27	S	14	S	-	-

* Brittle.

TABLE X.—LIST OF LABELLED CRABS SET FREE A THE MOUTH OF THE HARBOUR, DUNBAR—*continued*.

S stands for Soft (not Marketable). H stands for Hard (Marketable). H indicates that the Crab is nearly, though not quite, hard enough to be Marketable.

Set Free.				Recaptured.								
	Number of Individuals.	Numbers on the Labels.	Date.	Label Number.	Date.	Place.		Condition when Set Free.	Interval of Freedom. Days.	Condition when Re-captured.	Size in Inches.	Sex.
						Distance and Direction from Dunbar.	Depth in Fathoms.					
34	-	—	—	905	Oct. 9, 1899	2 miles N.E.	27	S	16	S	-	-
35	-	—	—	907	Oct. 14, ,,	3 miles N.E.	26	S	21	S	5⅝	Male.
36	-	—	—	897	Oct. 16, ,,	4 miles N.	24	S	23	H	5⅛	,,
37	-	—	—	903	Oct. 17, ,,	,,	,,	S	24	S	5⅝	Female.
38	-	—	—	891	Oct. 24, ,,	3½ miles E.S.E.	26	S	31	H	5¼	Male.
39	-	—	—	886	Oct. 26, ,,	2½ miles N.E.	23	S	33	H	4 11/16	,,
40	-	—	—	880	Nov. 21, ,,	6 miles N.	24	S	59	H	5⅝	Female.
41	-	—	—	896	Dec. 26, ,,	2½ miles N.	22	S	94	H	4 13/16	Male.
42	-	—	—	892	Jan. 16, 1900	2½ miles N.E.	,,	S	115	H	5¼	Female.
43	-	—	—	940	April 4, ,,	1 mile E.	13	S	193	H	—	,,
44	-	—	—	955	April 26, ,,	3 miles N.N.W.	7	S	215	H	5	Male.
45	-	—	—	953	May 4, ,,	3 miles W.	10	S	223	H	5⅝	Female.
46	51	1022-1072	Oct. 24, 1899	1025	Nov. 9, 1899	2 miles N.E.	20	S	16	S	6¼	-
47	-	—	—	1039	Nov. 17, ,,	2⅜ miles N.E.	24	S	24	H	5	Male.

48	-	—	—	1045	Nov. 18, ,,	3½ miles N.E.	,,	S	25	S	5 1/16	Female.
49	-	—	—	1029	Nov. 22, ,,	2½ miles N.E.	,,	S	29	S	5 1/16	,,
50	-	—	—	1052	Nov. 25, ,,	2 miles N.	22	S	32	S	5 7/8	Male.
51	-	—	—	1061	Nov. 30, ,,	2½ miles N. by E.	23	S	37	H	5¼	,,
52	-	—	—	1063	Dec. 15, ,,	3 miles N.N.E.	25	S	52	S	6	Female.
53	-	—	—	1040	Dec. 18, ,,	2½ miles N.E.	24	S	55	-	5 3/8	Male.
54	-	—	—	1064	Jan. 12, 1900	2 miles N.	20	S	80	H	5 3/4	,,
55	-	—	—	1032	Feb. 4, ,,	—	-	S	103	H	5 3/8	,,
56	-	—	—	1070	Feb. 13, ,,	4 miles N.	24	S	112	H	-	-
57	51	1123–1173	Nov. 4, ,,	1132	Nov. 13, ,,	2 miles N.N.E.	18	S	9	S	5 7/8	Male.
58	-	—	—	1136	,, ,, ,,	3 miles N.N.E.	22	S	9	S	5½	,,
59	-	—	—	1135	Nov. 15, ,,	2½ miles N.E.	23	S	11	S	5 13/16	,,
60	-	—	—	1167	,, ,, ,,	,,	,,	S	11	S	5 5/16	Female.
61	-	—	—	1172	Nov 16, ,,	2½ miles N.N.E.	21	S	12	S	7	Male.
62	-	—	—	1141	Nov 21, ,,	2½ miles N.E.	23	S	17	S	6 5/16	,,
63	-	—	—	1153	Nov 22, ,,	,,	,,	S	18	S	6 1/8	Female.
64	-	—	—	1144	Nov 30, ,,	,,	,,	S	26	S	5 7/8	,,
65	-	—	—	1134	Dec 2, ,,	,,	24	S	24	S	·	Male.
66	-	—	—	1151	Dec 15. ,,	,,	25	S	41	S	5 5/16	,,
67	-	—	—	1130	Dec 26, ,,	3 miles N.	20	S	52	S	6 1/8	,,
68	-	—	—	1166	Jan 11. 1900	2½ miles N.	22	S	68	H	5 7/16	,,
69	-	—	—	1140	Jan. 17, ,,	2½ miles N.E.	24	S	74	H	4 11/16	,,

TABLE XI.

LIST OF LABELLED CRABS SET FREE AT SOME DISTANCE FROM DUNBAR.

S stands for Soft (not Marketable). **H stands for Hard (Marketable).** **H indicates that the Crab is nearly, though not quite, hard enough to be Marketable.**
u indicates a Crab of under gauge size.

	Set Free.					Recaptured.									
	Number of Individuals.	Numbers on Labels.	Date.	Place (A). Distance and Bearing from Dunbar.	Depth in Fathoms.	Label Number.	Date.	Place (B). Distance and Bearing from Dunbar.	Depth in Fathoms.	Condition when Set Free.	Interval of Freedom—Days.	Condition when Recaptured.	Distance and Bearing of Place (B) from Place (A).	Size in Inches	Sex.
1	30	3201–3230	Jan. 11, 1898	1½ miles E.	16	3224	April 2, 1898	2 miles E.S.E.	10	uH	81	H	¾ mile S.E.	–	—
2	–	—	—	—	–	3218	,, 15, ,,	3 miles E.S.E.	16	uH	94	H	1½ miles S.E.	–	—
3	–	—	—	—	–	3223	May 16, ,,	3½ miles S.E.	12	uH	125	H	2½ miles S.E.	–	—
4	–	—	—	—	–	3202	,, 31, ,,	(Off Catcraig.)	6	uH	140	H	1½ miles S.	–	—
5	26	3255–3282	Feb. 8, ,,	2 miles E.	17	3260	April 7, ,,	,, ,,	–	uH	58	H	1 mile S.	–	—
6	–	—	—	—	–	3275	,, 18, ,,	3 miles E. by S.	–	uH	69	H	—	–	—
7	131	101–231	Nov. 7, ,,	2 miles E. by N.	20	182	Nov. 21, ,,	3 miles E.	23	S	14	S	1 mile E.S.E.	–	—
8	–	—	—	—	–	204	,, ,, ,,	,,	,,	uH	14	H	,,	–	—
9	–	—	—	—	–	225	Dec. 3, ,,	3½ miles E. by N.	30	S	26	S	1½ miles E. by N.	–	Female.

10	–	—	—	—	–	160	,,	27,	,,	2¾ miles E. by N.	28	S	40	S	¾ mile E by N.	–	—
11	–	—	—	—	–	173	,,	,,	,,	4 miles E. by N.	30	S	40	S	2 miles E. by N	–	—
12	100	232–331	Dec.	5, ,,	1 mile E. by N.	15	318	,,	15,	,,	2 miles E.	28	S	10	S	1 mile E.	–	—
13	–	—	—	—	—	–	282	,,	16,	,,	4 miles E. by N.	30	S	11	S	3 miles E by N.	–	—
14	–	—	—	—	—	–	265	,,	21,	,,	4 miles N.	19	S	16	H	4 miles N.	–	—
15	–	—	—	—	—	–	248	Jan.	4,	1899	3 miles N.E.	23	S	30	S	2 miles N.E.	–	—
16	–	—	—	—	—	–	316	,,	,,	,,	4 miles E.S.E.	,,	S	30	S	3 miles S.E.	–	—
17	–	—	—	—	—	–	298	,,	30,	,,	2 miles E.	21	S	56	H	1 mile E.	–	—
18	51	381–432	Jan.	26,	1899	about 2 miles S.E.	–	394	May	3,	5 miles S.E.	8	uH	97	H	3 miles S.E.	–	—
19	44	432–475	April	6,	,,	3 miles E. by N.	22	467	Aug.	7,	,,	(1 mile E. by S.)	18	uH	123	H*	1½ miles W.	–	—
20	47	699–745	July	15,	,,	,,	,,	709†	,,	18,	,,	3 miles N.E.	23	S	34	–	1¾ miles N.N.W.	–	Male.
21	–	—	—	—	—	–	742	Oct.	9,	,,	3 miles N.N.E.	25	S	86	H	3 miles N.W.	6¼	Male.
22	50	828–877	Aug.	18,	,,	2½ miles E. by N.	22	844	Sept.	11,	,,	2½ miles E. by N.	22	S	24	S	—	–	—
23	–	—	—	—	—	–	873	,,	13,	,,	,,	,,	,,	S	26	S	—	–	—
24	–	—	—	—	—	–	842	,,	29,	,,	2 miles E.	20	S	42	S	½ mile S.E.	–	—
25	–	—	—	—	—	–	861	Oct.	6,	,,	2 miles E.N.E.	22	S	49	S	½ mile W.N.W.	–	—
26	–	—	—	—	—	–	837	,,	11,	,,	2½ miles E.	25	S	54	H	½ mile S.	–	Female.
27	–	—	—	—	—	–	851	,,	,,	,,	3½ miles E.	26	S	54	H	1 mile E.S.E.	5¼	Male.
28	–	—	—	—	—	–	831	,,	17,	,,	2 miles E. by N.	23	S	60	H	½ mile E. by N.	4⅝	,,

* Brittle. † Caught on a haddock line.

Table XI.

LIST OF LABELLED CRABS SET FREE AT SOME DISTANCE FROM DUNBAR—*continued.*

S stands for Soft (not Marketable). H stands for Hard (Marketable). H indicates that the Crab is nearly, though not quite, hard enough to be Marketable.

	Set Free.					Recaptured.									
	Number of Individuals.	Numbers on Labels.	Date.	Place (A). Distance and Bearing from Dunbar.	Depth in Fathoms.	Label Number.	Date.	Place (B). Distance and Bearing from Dunbar.	Depth in Fathoms.	Condition when Set Free.	Interval of Freedom—Days.	Condition when Recaptured.	Distance and Bearing of Place (B) from Place (A).	Size in Inches	Sex.
29	–	—	Aug. 18, 1899	2½ miles E. by N.	22	856	Oct. 23, 1899	3½ miles E. by S.	25	S	66	H	1½ miles S.E.	$5\frac{8}{16}$	Male.
30	–	—	—	—	–	863	,, 27, ,,	3 miles N.E.	24	S	70	H	1½ miles N. by W.	$5\frac{8}{16}$	Female.
31	–	—	—	—	–	835	Nov. 9, ,,	3 miles E.	26	S	83	H	1 mile S.E.	$4\frac{8}{8}$	Male.
32	–	—	—	—	–	867	Dec. 9, ,,	3½ miles E.	26	S	113	H	1½ miles E.S.E.	$4\frac{11}{16}$	,,
33	–	—	—	—	–	841	,, 15, ,,	3 miles N.N.E.	25	S	119	H	$2\frac{3}{4}$ miles N.N.W.	$4\frac{1}{2}$	Female.
34	–	—	—	—	–	864	,, 25, ,,	3½ miles E.	27	S	129	H	1 mile E.S.E.	5	Male.
35	54	957–1010	Sept. 25, ,,	2½ miles E. by N.	25	992	Sept. 27, ,,	2½ miles N.E.	22	S	2	S	1½ miles N.W.	–	—
36	–	—	—	—	–	968	,, ,, ,,	2 miles N.E.	22	S	2	S	,, ,,	–	—
37	–	—	—	—	–	983	,, 28, ,,	,, ,,	,,	S	3	S	,, ,,	–	—
38	–	—	—	—	–	997	,, ,, ,,	2½ miles E.	20	S	3	S	½ mile S.	–	—
39	–	—	—	—	–	998	Oct. 6, ,,	2½ miles E.N.E.	25	S	11	S	½ mile N.N.W.	–	—
40	–	—	—	—	–	994	,, 14, ,,	4 miles N.	24	S	19	S	4 miles N.W.	$4\frac{13}{16}$	Male.

41	-	—	—	—	-	991	,,	23,	,,	2½ miles N.E.	23	S	28	H	1½ miles N.N.W.	5 3/16	Female.
42	-	—	—	—	-	973	,,	26,	,,	3 miles N.E.	25	S	31	H	1½ miles N. by W.	4 13/16	Male.
43	-	—	—	—	-	1000	Nov.	2,	,,	2 miles N.N.E.	19	S	38	H	2½ miles N.W.	4 13/16	,,
44	-	—	—	—	-	965	,,	13,	,,	3 miles N. by E.	22	S	49	H	3 miles N.W.	4 13/16	,,
45	-	—	—	—	-	982	,,	16,	,,	2 miles N. by E.	18	S	52	H	2½ miles N.W.	5½	,,
46	-	—	—	—	-	986	,,	18,	,,	7 miles N.N.W.	27	S	54	H	8 miles N.W.	5 3/16	,,
47	-	—	—	—	-	957	Dec.	26,	,,	2½ miles N. by E.	26	S	92	H	3 miles N.W.	5	Female.
48	-	—	—	—	-	980	April	19,	1900	2 miles N.W.	7	S	206	H	4 miles W.N.W.	5⅛	Male.
49	-	—	—	—	-	1007	,,	26,	,,	1 mile E. of Kingsbarns.†	8	S	213	H	18 miles N.	5	Female.
50	-	—	—	—	-	1002	,,	28,	,,	1½ miles S.E.	7	S	215	H	2 miles S.W.	5	Male.
51	-	—	—	—	-	960	May	3,	,,	¼ mile S.E.	8	S	220	H	2 miles W. by S.	5 1/16	Female.
52	51	1073–1123	Oct.	26, ,,	1½ miles E. by N.	17	1092	Nov.	4,	,, 2½ miles N.E.	25	S	9	S	1½ miles N. by E.	5⅜	Male.
53	-	—	—	—	—	-	1082	,,	13,	,, 2 miles N.N.E.	18	S	18	S	2 miles N.N.W.	6 9/16	,,
54	-	—	—	—	—	-	1084	,,	15,	,, 2⅜ miles N.E.	24	S	20	S	2 miles N.N.E.	6⅝	,,
55	-	—	—	—	—	-	1118	,,	,,	,, ,,	,,	S	20	S	,, ,,	6 7/16	Female.
56	-	—	—	—	—	-	1115	,,	17,	,, ,,	,,	S	22	S	,, ,,	5⅝	Male.
57	-	—	—	—	—	-	1099	Dec.	12,	,, ,,	,,	S	47	H	,, ,,	6⅞	Female.
58	-	—	—	—	—	-	1104	,,	26,	,, 2 miles N.	17	S	61	H	2 miles N.W.	5 3/16	Male.
59	-	—	—	—	—	-	1111	Jan.	7,	1900 1½ miles E. by N.	16	S	83	H	—	6⅜	,,
60	-	—	—	—	—	-	1080	,,	20,	,, ,,	,,	S	86	H*	—	4 13/16	,,
61	-	—	—	—	—	-	1076	April	26,	,, 1 mile S.E.	4	S	179	H	2 miles S.W.	5½	Male.
62	-	—	—	—	—	-	1113	May	4,	,, S.E.	14	S	187	H	2½ miles S.E.	5⅝	,,

* On 4th February it was still not quite hard. † St. Andrews Bay.

The Regulation of the Crab Fishery.

The aim of regulation in the case of a fishery is usually either to arrest a decrease in its productivity, or to increase the commercial value of its returns. In discussing, then, the question of interference with the present mode of conducting the crab fishery, it is necessary to consider whether or not (1) there are signs that it is declining, (2) if by regulation the fishery might be so improved that it make a better return to those most interested—viz., the fishermen. With regard to the first question, the Crab and Lobster Commission of 1877 came to the following conclusion:—"We are ourselves of opinion that the crab fisheries on the East Coast of Scotland are almost universally deteriorating."* Wilson† reported in 1893, regarding the crabs on the coast of Northumberland, that—"there is no evidence of a steady decline in the aggregate take, except at one or two places. But that there is *at least* danger of over-fishing is indicated by the fact that the increase in gear is not yielding corresponding increase of crabs." Meek‡ was of the opinion that the crab and lobster fishery had deteriorated in the Northumberland district. The annexed Table, extracted from the Reports of the Fishery Board, gives the numbers of crabs landed in the Eyemouth and Leith districts, on the East Coast of Scotland, and also the landings for the whole of Scotland, for the period from 1883 to 1899 inclusive.

	Eyemouth District.	Leith District.	East Coast of Scotland.	East and West Coasts, Orkney and Shetland Islands.	Number of Creels owned by the Fishermen.
	Hundreds.	*Hundreds.*	*Hundreds.*	*Hundreds.*	
1883	15,841	6,196	32,196	35,393	-
1884	-	-	-	33,178	-
1885	15,550	4,780	31,061	32,499	-
1886	2,281	6,173	21,193	23,846	-
1887	3,173	6,577	21,034	22,157	-
1888	3,082	8,275	29,676	30,817	-
1889	2,720·5	6,445·5	26,090	27,743	-
1890	2,710·5	7,654	27,335·9	28,823	-
1891	2,746	7,630·5	29,753	30,924	-
1892	3,620	8,192	30,269	31,179·9	-
1893	3.819	9,084	31,638	33,050	69,331
1894	4,145	7,359	25,684	26,801	75,198
1895	3,568	6,151	24,058	25,482	71,968
1896	6,041	10,101	32,569	33,973·8	72,790
1897	3,947	9,186	32,672	34,943·9	73,651
1898	5,434	9,533	35,330	36,465·8	77,157
1899	3,765	8,600	29,611·5	31,125	76,007

* p. v. † *Op. cit.*, 1893, pp. 3, 4.
‡ *Op. cit.*, 1899, p. 41.

It is seen from the yearly totals that although very great variations occur from year to year, in 1898 the take was slightly larger than the total in 1883; these two were the years in the period in which the yield of the fishery reached 3,500,000 crabs. The number of creels owned by the fishermen has been entered for the seven years 1893–1899 inclusive. There is no evidence to show what proportion of these creels were actually employed in fishing for crabs, but as they do not last very long, but require continual repair or renewal, it is probable that a very small percentage, if any, was unemployed. If, then, it be conceded that the number of creels returned as belonging to the fishermen were actually used, we see that an increase in catching gear does not imply an increase in the take. Thus in 1893, with 69,000 creels, the catch was 3,305,000 crabs; and in 1894 and 1895, with a greater number of creels, viz., 75,000 and 72,000, fewer crabs, namely 2,548,200, were captured. Greater catches were obtained in 1896 and 1897 than in 1894 and 1899, when a larger number of creels was owned. It is therefore apparent that an increase in the catching gear is not always accompanied by an increased catch. The only conclusion which is at present permissible is that a decline in the fishing is not indicated. Nor, on the other hand, is there any indication of regular increase in the number of crabs. Everything seems to point to the probability that the fishing is carried on to its fullest extent. Previous to the passing of the Crabs and Lobsters Act of 1877, there was seemingly a deterioration; since then, judging from the period above cited, such deterioration has apparently ceased. The provisions of the Act, prohibiting the sale of soft crabs and of hard under-sized crabs, might then be regarded as having effected a desired improvement. But, nevertheless, the exemption in favour of the use of these two classes of crabs as bait left the fishing, in those districts where it is carried on during the whole year, in a state similar to what obtained previous to the passing of the Act. The ground frequented by crab-fishers is altogether littoral, seldom extending more than four to five miles from the shore, although, as one witness stated before the Commission,* crabs may be got on the haddock lines shot in the Moray Firth 10 to 15 miles offshore. The crabs which were taken by the trawlers were got during inshore trawling mainly. It is important to consider what percentage of the catch of the crabs is protected by the Act. So far as the ten catches which were measured (Table IX.) may be taken as representative, the percentage of crabs below 4¼ inches was 12·5 per cent. That proportion may, then, be taken as the extent of the protection of small crabs, if they are not used for bait. But their general destruction for this purpose renders the Act quite ineffective. The protection to soft crabs is also more apparent than real, for where the crab-fishing is pursued during autumn and winter the permission to bait their lines with soft crabs is largely taken advantage of. In regard to these two provisions, then, the Crab and Lobster Act was to a large extent inoperative. Berried crabs are afforded protection irrespective of the prohibition of their sale enacted by the Act; for, as Wilson and Cunningham point out, in this corroborating the evidence furnished to the Commission, the berried crab seldom appears in the crab-pot. At Dunbar very few berried crabs are got in the year. Notwithstanding, then, the fact of the meagreness of the protection to the mature group, the takes of crabs have not permanently decreased.

The second aim of regulation of a fishing is to increase its profit. Petersen,† in his work on the commercial flat-fishes of Denmark, says :—

* Reports on the Crab and Lobster Fisheries, 1877, evidence for Scotland, pp. 39, 40.

† *Report by the Danish Biological Station to the Home Department*, IV., 1893, Copenhagen, 1894, p. 67.

"In order to promote the plaice-fishery, *in our seas* at any rate, it is not enough to protect the *unsaleable* fish only; we must also, and particularly, protect the *saleable* fish, so that the latter becomes sufficiently saleable. I am convinced that no other way will lead us to the goal, the greatest possible profit." Such an improvement in value may be obtained by an increased catch, or by securing a higher price for each individual crab. The former need not be considered here; the latter is a line on which some progress may be made. The first point to which attention may be directed is the fact that the smallest legally saleable crabs are not accepted as full marketable crabs. The smaller crabs of the catch sell at half the price of the larger. At Dunbar, for example, although no definite size in inches is accepted as the standard by which a whole crab is measured, it may with confidence be stated that all crabs under $4\frac{3}{4}$ inches across will be counted as half-crabs. The highest price paid to the fishermen at Dunbar for crabs is 1s. 6d. per dozen—*i.e.*, each crab brings three halfpence. Crabs under $4\frac{3}{4}$ inches are sold at three farthings each. The capture of half-crabs is economically a mistake, since by leaving them in the sea until they cast again, their size would be much increased. They would on recapture bring double their former value.* In the ten catches referred to above, 2684 crabs were of marketable size ($4\frac{1}{4}$ inches and over), and of these 597 were found to be between $4\frac{1}{4}$ and $4\frac{5}{8}$ inches inclusive; *i.e.*, 22 per cent. of the crabs of marketable size were half-crabs. After one cast, all of these crabs would measure more than 5 inches across (*vide* p. 110). Then if only half of these were recaptured when they had increased in size, no loss would accrue to the fishing, since their value had doubled itself. The question arises as to how long a period will elapse before a crab between $4\frac{1}{4}$ and $4\frac{5}{8}$ would cast again. In the case of a female which was fertilised, two years at least would probably elapse between its soft period and the next casting; but during that time it is more than probable that she will carry eggs. In the case of an unfertilised female of these sizes, a year may be taken as the interval between the time of its previous cast and the following one. With regard to the male crab, it is not improbable that the similar interval will be one of two years at least. But on this point evidence is wanting. Taking everything into consideration, it would very probably be an advantage to eliminate the half-crabs from the market. And for this purpose a $4\frac{3}{4}$ inches gauge at the very least would be required. The Crab and Lobster Commission recommended for Scotland a 5 inches gauge, and instead of that size $4\frac{1}{4}$ inches was taken as the standard. In most of the fisheries districts in England (*vide* p. 140) the $4\frac{1}{4}$ inches gauge has been by local bye-law replaced by a minimum of 5 inches. This is a size which would keep out the Dunbar half-crabs; but care should be taken against instituting a gauge which is larger than absolutely necessary. A 5 inches gauge would have kept out 35 per cent. of the crabs measuring $4\frac{1}{4}$ inches and over in the sample catches which were examined (p. 119), while a $4\frac{3}{4}$ inches gauge would have caused the rejection of 22 per cent.

Even without further restriction in the matter of the minimum legal size, much good might be done by preventing the use of the small hard crabs and soft crabs for bait. The Crab and Lobster Commission in this connection reported as follows:—"There is, then, much diversity of opinion among the fishermen of Scotland as to the expediency or inexpediency of using crabs for bait. Without expressing any opinion on the propriety of the practice, we may repeat that we cannot recommend any legislative interference with its continuance, because we are

* Wilson, *op. cit.*, 1895, p. 5; Allen, "The Protection of Crabs and Lobsters," *Journal, Marine Biological Association*, N.S., Vol. IV., No. 2, p. 186.

satisfied that if such a law were made it would be impossible to enforce it. There is another matter* which we believe requires attention. The fishermen who fish in the autumn months are in the habit of destroying large numbers of 'soft' or 'light' crabs. These crabs, which have recently cast their shells, are worthless as food. We propose that it should be illegal to expose these crabs for sale. We should have been very glad to have been able to recommend that they should not be taken, and we exeedingly regret that we cannot do so, for two reasons. First, because, as we have already stated, there is no available machinery for enforcing a law of this nature on the coast, and we are unable to see how any efficient machinery for the purpose can be provided except at very great cost; and second, because these crabs are used as bait. The only practicable remedy we believe to consist in the institution of local close seasons applicable to those places where, and times when, soft or light crabs are wantonly destroyed." The difficulty of enforcing such a regulation is probably not so great now as it was when the Commission made its report. The use of crabs for bait may be considered from two points of view, (1) the efficiency of the flesh of the crab as a bait for fish, (2) what saving in the fisherman's expenditure results from the use of the crabs in this manner. It is generally considered by the fishermen that the crab is a more attractive bait than the mussel. But on this point experimental evidence is wanting. Certain data bearing upon the expenditure which is avoided by using crabs for bait have, in the case of Dunbar, been obtained. A large soft crab affords not more than four baits. To bait 400 hooks requires 100 crabs. The cost of mussels as bait for 400 hooks does not exceed ninepence, while 100 hard large crabs, if taken at the moderate value of 1s. per dozen, bring 8s. 4d. A potential return of 8s. 4d. after four months, the period required for the soft crab to become hard, is then sacrificed for a quantity of mussels of the value of ninepence. These crabs, if returned to the sea, would after four or five months have their value increased on recapture tenfold. In order that the fishermen may have returned to them the expenditure on mussels entailed by the protection of the soft crabs, it is necessary that only ten crabs out of the 100 be recaptured. As to what proportion might be expected to be recaught, some data are afforded by the labelling experiments. Of the soft crabs which were marked and then set free, 11 per cent. were recovered, and as it is no doubt the case that a proportion of these crabs succumbed in consequence of their necessary exposure to the air for longer or shorter intervals, the percentage of the survivors which were retaken is probably even greater than 11.† It may then with a considerable amount of certainty be maintained that 10 per cent. at least of the soft crabs returned to the sea immediately on being taken from the creels would be recaptured in the hard condition. In this way the fishermen would suffer no loss. An average estimate of the number of crabs used for bait by each boat during autumn and part of the winter is 100 crabs per day. 100 crabs are looked upon as a reasonable number per boat; some boats take more. Now, soft crabs are got during September, October, November, and December — four months; it is at once apparent that the destruction which may ensue through this practice is enormous. Statistics of the extent to which the crab is used for bait do not exist, but from the statistics of the catch of one boat during the last four months of 1899 (Table XII.) it is seen that, with the exception of eight days at the end of December, more than 100 soft crabs were obtained each day. For the 52 days on which the fishing was prosecuted, it was, then, permitted by custom to the one boat to

* p. xiii.

† Of some lots a very much higher percentage was recovered. Thus, in six cases, the following were the percentages recaptured, viz., 20, 20, 22, 25, 25, and 31.

destroy 5200 crabs. If this is multiplied by the number of boats engaged in the fishing, a number of crabs is obtained the destruction of which is a serious loss to the fishery. In addition to a loss through the breaking up of soft crabs, a further injury is done during the rest of the year by the use of small hard crabs for bait. A small crab supplies only two baits. It has certainly been the case to some extent lately that the fishermen have been forced to buy trawled fish bait for their creels. This was owing to the scarcity of haddocks in the inshore waters; but so long as the fish are sufficiently abundant to repay the labour of baiting the lines, crabs are used for bait.* In the North-Eastern and Eastern districts of England the use of small and soft crabs for bait is forbidden. In the Northumberland district, although no prohibition exists, the fishermen are not accustomed to use crabs for this purpose. The question then arises, in the event of this practice being prohibited, whether the only method of securing the enforcement of the law is a close time. The Commissioners appointed to inquire into the state of the crab fishery were of this opinion, but the conditions are now much different. A close time, from the 1st September of one year to the 31st day of January following, is in force in the North-Eastern district of England; and in 1898 an inquiry was held by Mr. W. E. Archer and Mr. H. N. Malan, Inspectors of Fisheries, into objections which were raised to the proposal of the Northumberland Sea Fisheries Committee to enact a close time of a similar extent in the district under their jurisdiction. In their report to the Board of Trade† Messrs. Archer and Malan summed up in opposition to the confirmation of the proposed bye-law, which would have imposed a close time of five months' duration. They say that "some of the evidence given to us might have justified our recommending a shorter period if there had been less conflict of opinion as to the months in which soft crabs are really taken in the greatest numbers." . . . "Further, from the statistics collected for the Board of Trade, it appears that during the five months in question a considerable number of crustaceans, especially crabs, are taken, and that at some stations the fishing is carried on at no inconsiderable profit all the year round."

With a view to arriving at the proportion of soft crabs in the catches during the proposed close time, and also in order to find out the value of the fishery during that period, arrangements were made for having statistics kept of the daily catch of one Dunbar boat. Mr. Hutchison, the deputy Fishery Officer, undertook the matter. The catch was divided into soft and hard crabs; each class was sub-divided into crabs of 4¼ inches and over, and crabs under that size. The statistics are arranged in Table XII. The number of creels used on each of the 60 occasions that the fishing was prosecuted was 60. The totals for each month appear in Table XIII., where the percentages of hard and soft crabs are also given. Of the gauge crabs in September an average of 80 per cent. consisted of soft crabs; in October and November the soft crabs made up 55 and 42 per cent. of the gauge crabs respectively; and in December the proportion of soft crabs had fallen to 22 per cent.; in January only 2 per cent. of the gauge crabs were soft. It is then evident that, so far as the Dunbar evidence is applicable to other districts, a close time of five months is not required for the protection of soft crabs. And since there appears to be no indication of the species being seriously reduced in numbers, any special protection which the above close time would afford the spawning crabs is not called for.

* Along with mussels, limpets, and lobworms.

† Sea Fisheries Regulation Acts, 1888-1894: Report by Mr. W. E. Archer and Mr. H. N. Malan, Inspectors of Fisheries, on an Inquiry into Bye-laws made by the Committee for the Northumberland Sea Fisheries District with respect to Lobsters and Crabs, 7th January 1899.

During these five months of the year a considerable number of saleable crabs are obtained. In this case the catch contained 20,212 crabs. In October the price of crabs was 1s. 3d. per dozen; in November 9d., 1s., in December 9d., and in January 1s. and 1s. 3d. The approximate value of the catch, then, was—September, £11 3s.; October, £23 15s.; November, £14; December, £19 2s.; January, £17. The total catch, then, for 70 days at sea brought £77, in which the four men forming the crew participate. There is thus, over the period of 19 weeks, an average of £4 7s. for the boat each week. The income is, of course, subject to deductions of the expenses of the fishing. In the event of a proposal to stop the crab fishing during the autumn and winter, some alternative mode of fishing which would recoup the fishermen ought to be available. Unfortunately the only alternative in this case is line fishing, and that has during the past few years been unremunerative. In 1895 and 1896 the value of the line-caught fish landed at Dunbar was £3150 and £3874 respectively, while in 1898 and 1899 the values were £1567 and £1704.

The institution of a close time for the protection of the soft crabs is a remedy which would press hardly in many localities. On the other hand, the impossibility of otherwise protecting the soft crabs is not proved. It is no doubt the case that soft crabs are often carelessly and even wantonly destroyed. But if the use of soft crabs for bait be prohibited, and the law which forbids their possession for any purpose other than bait enforced, some benefit would undoubtedly accrue. It is an error to suppose that the soft crabs succumb readily to slight injury. All the soft crabs which were labelled at Dunbar had to be brought ashore, and before they were labelled and returned to the sea they were in some cases out of the water for six hours. Still, many have been recovered. The majority of the soft crabs could be returned to the sea immediately; the only case when the thumb test is necessary is when the crab has become almost hard enough to be marketable. Even when this test is applied, it is not necessary to break the shell. The destruction of soft crabs takes place mainly in harbour. They are after exposure to air more liable to succumb to injuries. In the case of very soft and light crabs, when the crab has been out of water some time, the gill chamber becomes filled with air, and on the crab being thrown overboard it floats. It is often unable to get rid of the air. If, however, the crab be held in the water with its anterior edge upwards, the air escapes and the crab sinks. Many crabs recover from injuries sustained through the thumb test. Twenty-five crabs were labelled and set free after the thumb had been pushed through their shells. One was recovered.

There is good ground for the conclusion that the protection of small and soft crabs would tend to improve the crab fishery; and since it is principally the crab fishers themselves who use these crabs for bait, what they lost by the slightly increased expenditure for bait would with every probability be more than returned to them in improved catches. The increase of the legal minimum size, with a view to exclude the so-called half-crabs from the market, is also probably economically justifiable.

The Crab and Lobster Act, &c.

The Fisheries (Oysters, Crabs, and Lobsters) Act (40 and 41 Vict., ch. 42) enacted:—Section 8—A person shall not take, have in his possession, sell, expose for sale, consign for sale, or buy for sale—

(1) Any edible crab which measures less than four inches and a quarter across the broadest part of the back; or

(2) Any edible crab carrying any spawn attached to the tail or other exterior part of the crab, whether known as "berried crab," "seed crab," "spawn crab," or "ran crab." or by any other name; or

(3) Any edible crab which has recently cast its shell, whether known as a "caster," "white crab," "white-footed crab," "white-livered crab," "soft crab," "glass crab," or by any other name.

Here follows penalty:—

Provided that a person shall not be guilty of an offence under this section if he satisfies the Court that the edible crabs found in his possession, or alleged to have been sold, exposed for sale, consigned for sale, or bought for sale, were intended for bait for fishing.

The Act simply protects certain crabs from being sold; any small, soft, or berried crab may be used for bait.

Since the creation of the District Fisheries Committees in England, the provisions of the Act have been modified by local bye-laws.

Increase in the Minimum Size.—The smallest legal size has been raised to 5 inches across the broadest part of the back in Devon, Cornwall, Western, and Cumberland districts; to 6 inches in Lancashire district.

The Use of Crabs for Bait.—The exemption from Section 8, which permits of the use of under-sized and soft crabs for bait, is withdrawn in the North-Eastern and Eastern districts.

Close Time.—In the North-Eastern district there is in force a bye-law instituting a close time for crabs from 1st September of any year to 31st January of the following year. In the Eastern district there is a close time for the crab known locally as "white-footed" between 1st November of any year and the 30th June of the following year.

With regard to the return to the sea of illegally-caught shell-fish, it is enacted in the Northumberland, North-Eastern, Eastern, Western, Lancashire, and Cumberland districts that any person who takes any shellfish, the removal of which from a fishery is prohibited by any bye-law in force in the district, or the possession of which is prohibited by any Act of Parliament, shall forthwith deposit the same, without injury, as nearly as possible in the place from which it was taken.

Exemption for Scientific Purposes.—Provided that nothing in these bye-laws shall apply to the removal of crabs or lobsters for scientific, stocking, or breeding purposes by any person acting under the written authority of the local Fisheries Committee.

TABLE XII.

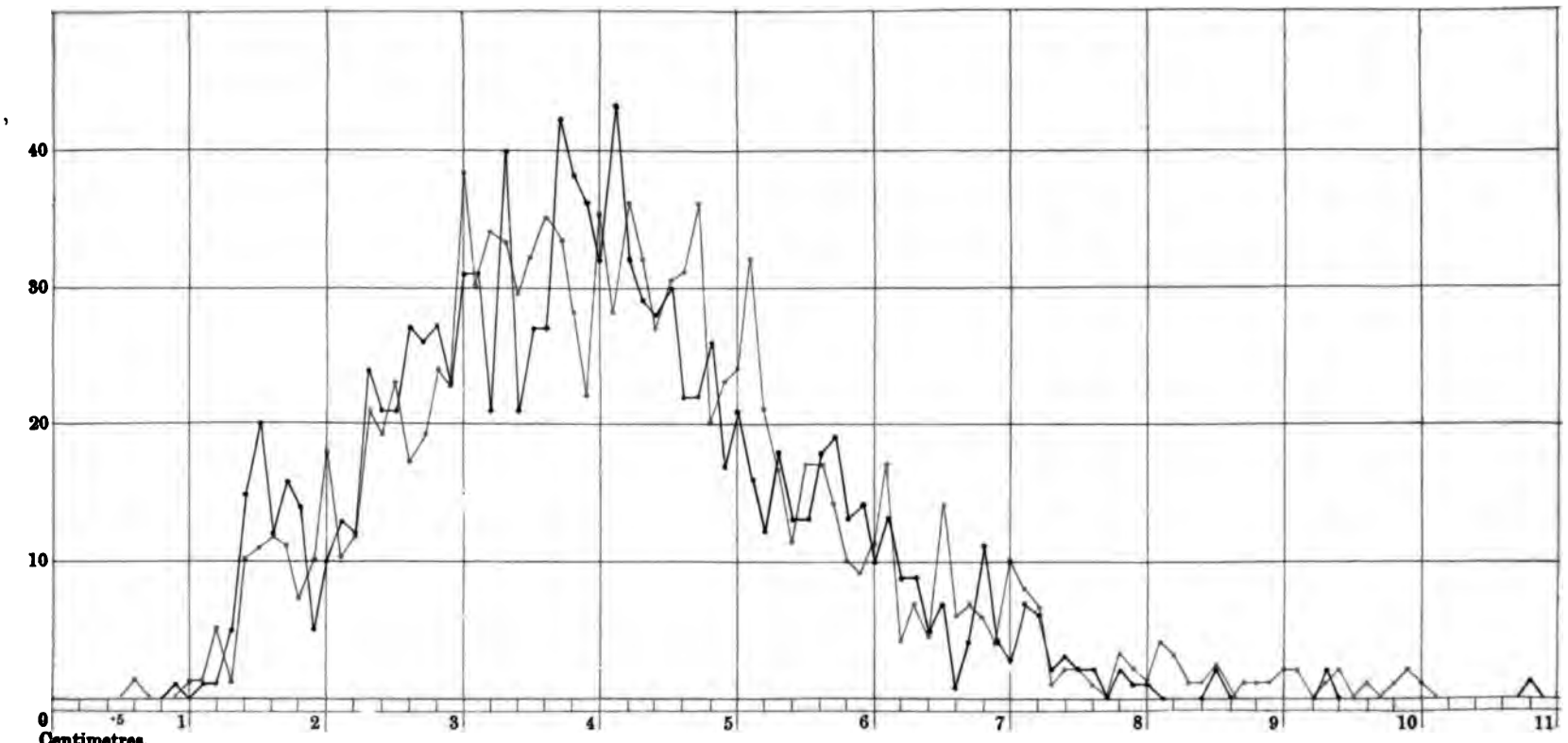
Daily Catch of one Dunbar Boat during September to December, 1899, *and January*, 1900.

Fishing Ground.	Date.	Hard Crabs.		Soft Crabs.		Number of Boats empl'y'd in Crab Fishing.
		Gauge Size.	Under Gauge Size.	Gauge Size.	Under Gauge Size.	
½ miles E. by N. of Dunbar—25 fathoms.	1899. Sept. 13	190	-	873	-	8
	,, 14	183	-	740	-	,,
	,, 15	159	-	700	-	,,
	,, 16	138	-	680	-	,,
	,, 20	176	-	670	-	,,
	,, 21	158	-	640	-	,,
	,, 23	177	-	666	-	,,
	,, 25	206	-	727	-	,,
	,, 26	178	-	830	-	,,
	,, 27	163	-	610	-	,,
	,, 28	204	-	645	-	10
	,, 29	215	4	893	30	,,
	Oct. 4	192	16	532	24	12
	,, 5	310	140	520	170	,,
	,, 6	265	150	567	130	,,
	,, 7	274	312	200	280	,,
	,, 9	308	180	320	120	14
	,, 10	206	160	110	140	,,
	,, 11	186	170	150	130	,,
	,, 12	180	186	100	170	17
	,, 14	250	160	300	140	,,
	,, 16	336	170	400	120	,,
	,, 17	320	150	473	102	,,
	,, 18	227	210	200	170	,,
	,, 19	174	156	150	340	,,
	,, 20	130	200	110	130	,,
	,, 21	85	165	150	128	,,
	,, 23	157	156	200	140	,,
	,, 24	252	180	213	220	,,
	,, 25	276	222	360	170	,,
	,, 27	243	390	227	120	,,
	,, 30	193	184	313	300	,,
	Nov. 4	182	60	265	250	,,

TABLE XII.—*continued.*

Fishing Ground.	Date.	Hard Crabs.		Soft Crabs.		Number of Boats empl'y'd in Crab Fishing
		Gauge Size.	Under Gauge Size.	Gauge Size.	Under Gauge Size.	
3 miles E. by N. of Dunbar—26 fathoms.	1899. Nov. 6	168	46	273	200	17
	,, 9	236	58	220	170	,,
	,, 13	234	64	370	156	,,
	,, 15	254	72	254	300	,,
	,, 16	190	42	200	150	,,
	,, 17	177	106	114	168	,,
	,, 18	148	64	80	200	,,
	,, 20	504	76	250	30	,,
	,, 21	507	68	200	100	,,
	,, 22	400	40	146	54	,,
	,, 25	440	38	230	112	,,
	,, 30	386	28	150	30	,,
	Dec. 1	309	30	175	46	,,
	,, 2	320	45	215	36	,,
	,, 5	619	74	207	12	,,
	,, 6	634	110	285	24	,,
	,, 9	510	96	206	10	,,
	,, 12	496	166	170	18	,,
	,, 13	396	200	98	28	,,
	,, 14	380	93	73	12	,,
	,, 15	396	112	55	8	,,
	,, 18	330	54	34	10	,,
	,, 19	356	60	38	6	,,
	,, 22	422	110	50	8	,,
	,, 25	308	154	45	10	,,
	,, 28	326	14	30	5	,,
	,, 30	342	65	22	8	,,
	1900. Jan. 8	386	16	14	8	9
	,, 11	364	12	8	6	,,
	,, 12	238	9	6	4	,,
	,, 13	240	7	4		,,
	,, 16*	547	18	12	9	,,
	,, 20	562	15	8	6	,,
	,, 24	672	12	8	7	,,
	,, 27	522	10	6	4	,,

* Includes the catches of the 14th, 15th, and 16th January.



The Black Curve is the curve of the measurements of Male Crabs } Collected between Tidemarks,
The Red Curve is the curve of the measurements of Female Crabs } 2,336 in number.

PLATE II.

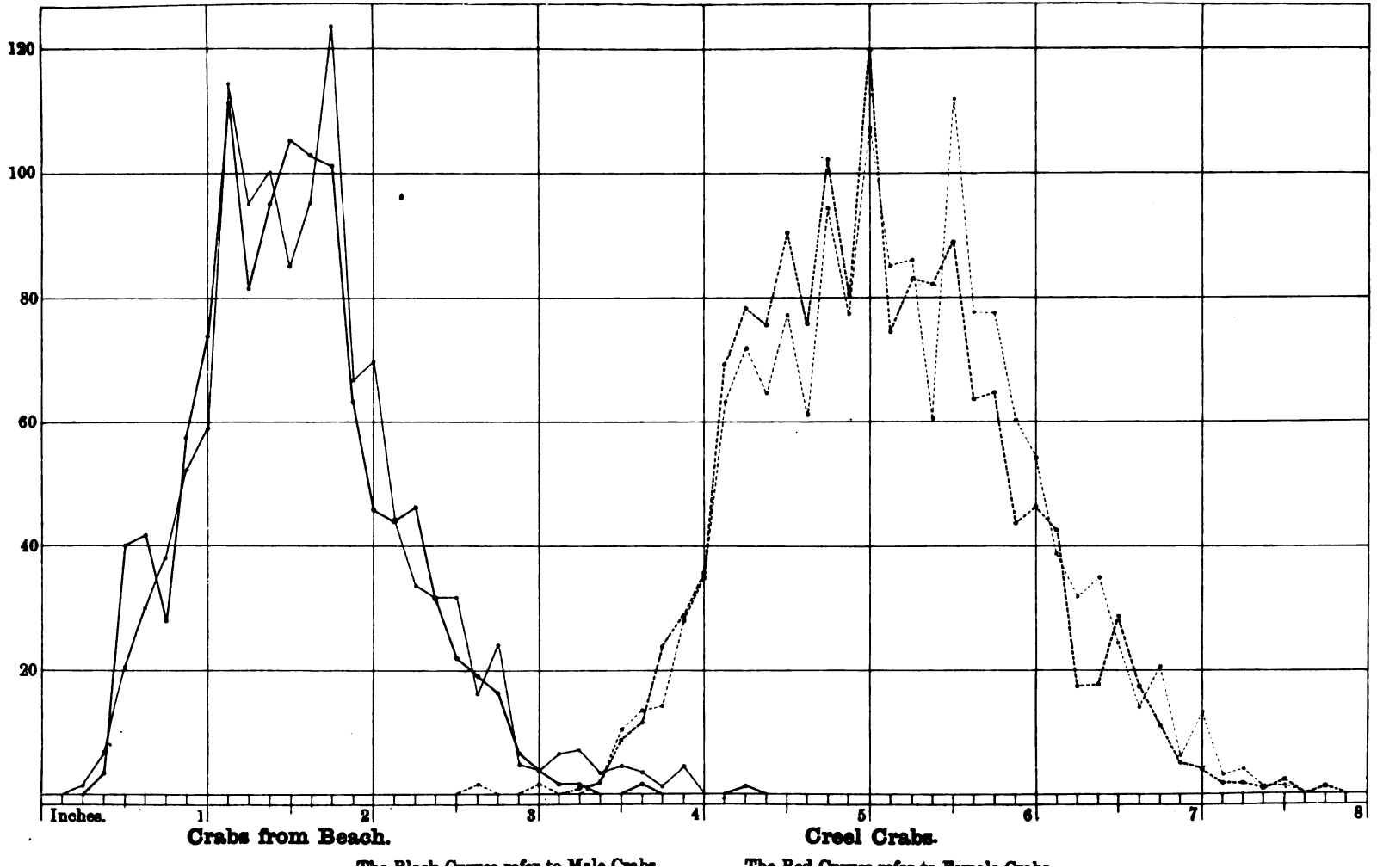

120
100
80
60
40
20
Inches.
1
2
3
4
5
6
7
8
Crabs from Beach.
Creel Crabs.

PLATE III.

Chart of Coast from Thornton to North Berwick.

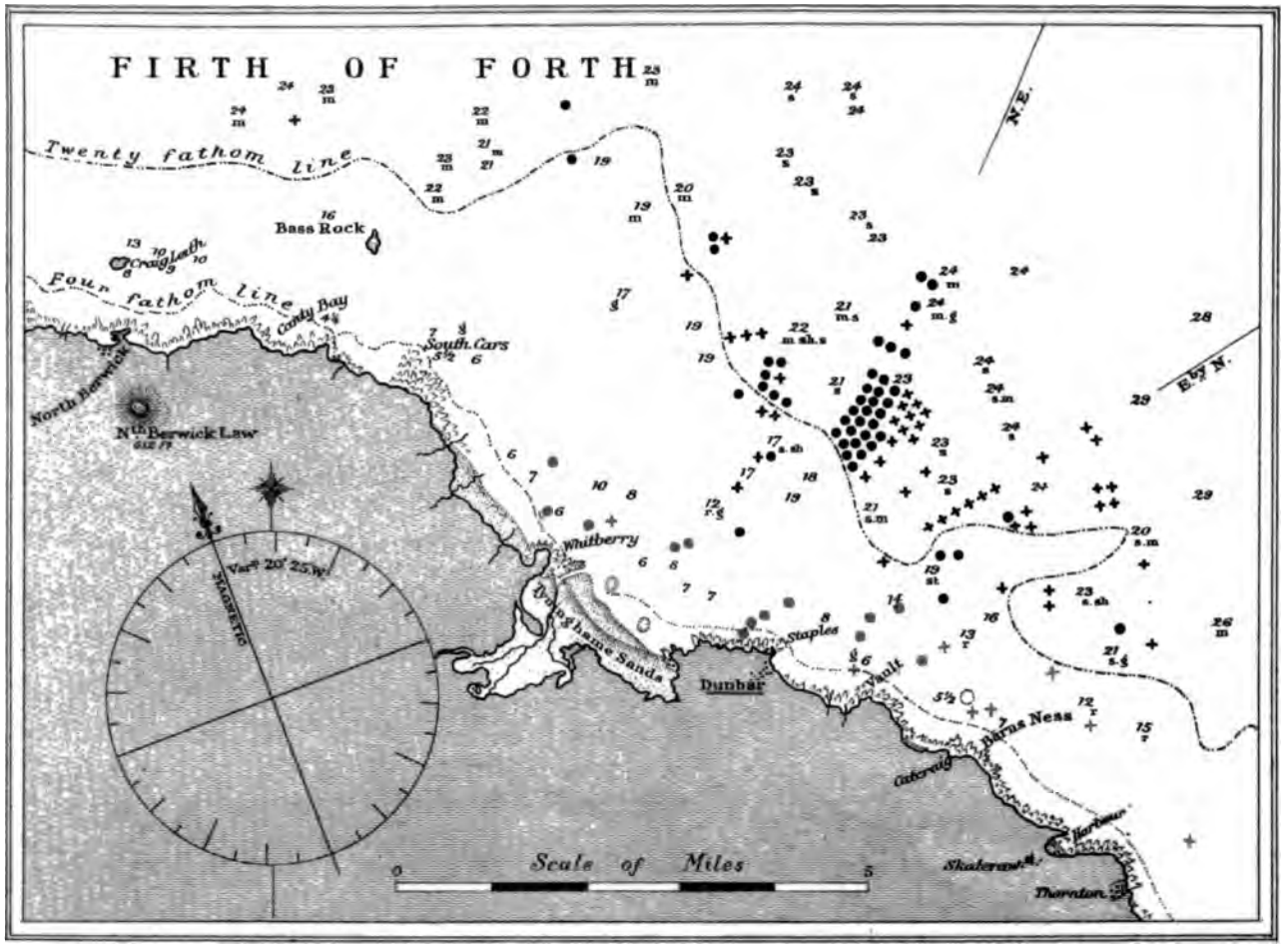


PLATE IV.

TABLE XIII.

Analysis of Daily Statistics—September, October, November, December, 1899, *and January,* 1900.

1899-1900.	Number of Times at Sea.	Gauge Crabs—4¼ inches and over.						Under-Gauge Crabs.	
		Hard Crabs.	Soft Crabs.	Total Number Hard and Soft.	Percentage of Hard.	Percentage of Soft.	Average Number of Soft Crabs each day.	Hard.	Soft.
September, 1899,	12	2,147	8,674	10,821	20	80	723	4	30
October, ,,	20	4,564	5,595	10,159	45	55	280	3,657	3,144
November, ,,	13	3,826	2,752	6,578	58	42	212	762	1,920
December, ,,	15	6,144	1,701	7,845	78	22	113	1,383	241
January, 1900.	10	3,531	66	3,597	98	2	8·5	99	49

DESCRIPTION OF PLATES.

PLATE I.

Fig. 1. Vagina and Spermatheca of a Soft Crab 5⅞ inches across. *o.*, ovary : *pl.*, plug : *ant.*, anterior surface: *pst.*, posterior surface.

Fig. 2. Larva of *Carcinus mœnas*, second stage. 24 hours after hatching. August 2nd, 1899.

Fig. 3. Vaginal plug. *a.*, the half next the median line of the thorax : *b.*, the half next the outer edge of the thorax.

Fig. 4. Larva of *Cancer pagurus*, second stage. 15 minutes after hatching. July 21st, 1899. *sp.*, lateral spine. The outer branches of the maxillipedes are shown on the right side only; and the inner branches of the same are alone shown on the left side.

Fig. 5. Spermatheca and Vagina of a Soft Crab 6¼ inches across. *ss.*, the secreting inner surface of the Spermatheca : *o.*, ovary : *v.*, vagina.

Fig. 6. Spermatheca and Vagina of a Soft Crab, showing plug *in situ*: *sp.*, wall of spermatheca : *v.*, wall of vagina : *pl.*, plug.

Fig. 7. Dissection of the Chela of a Crab near the fracture-plane, showing the two septa, *c.*, which remains attached to the cast-off limb : *d.*, which remains on the basi-podite. *a.*, the basi-ischiopodite joint: *b.*, meropodite.

Fig. 8. Portion of Vaginal Plug found on the abdomen of a male crab : *pl.*, plug : *ap.*, anterior element of penis : *pp.*, posterior element of penis.

Fig. 9. Spermatheca of Hard Crab; *sm.*, mass of sperms : *sl.*, secretion of spermatheca, solidified. *ood.*, opening of oviduct.

Fig. 10. The Carapace of a Male Crab, *a.*, and of a Female Crab, *b.*, natural size, 6½ inches across.

Fig. 11. Spermatozoon of *Cancer pagurus*: *a.*, seen from above, *b.*, seen from the side.

PLATE II.

Curves of the measurements of Beach Crabs. The divisions on the *abscissa* denote centimetres ; on the *ordinate* are marked off the number of individuals.

PLATE III.

Curves of the measurements of Beach and Creel Crabs. The standard of measurement is an inch.

PLATE IV.

Chart of a portion of the coast near Dunbar, showing the places where the Marked Crabs were recovered (*vide* p. 121).

III.—NOTES ON SOME CRUSTACEAN PARASITES OF FISHES.

By Thomas Scott, F.L.S., Mem. Zool. Soc. de France.

Plates V.–VIII.

Contents.

	PAGE.
Introductory Note,	144
Copepod-Parasites of Fishes—Ergasilidæ,	146
,, ,, ,, —Caligidæ,	147
,, ,, ,, —Dichelestidæ,	159
,, ,, ,, —Lernæidæ,	160
,, ,, ,, —Chondracanthidæ,	163
,, ,, ,, —Lernæopodidæ,	169
Branchiura,	179
Isopoda parasita,	180
Amphipoda parasita,	180
List of Fishes on which Parasites have been found,	181
Concluding Remarks,	182
Description of the Plates,	183

INTRODUCTORY NOTE.

Parasitic habits are not restricted or peculiar to any particular class of organisms, but may be found more or less in evidence in all departments both of the animal and vegetable kingdoms. There are, however, certain groups of plants and animals whose surroundings and conditions of life seem to be specially favourable to the adoption of parasitic habits, and amongst the Crustacea such habits seem to prevail to a considerable extent, especially amongst the so-called "lower forms" belonging to that class.

Different kinds of animals have to act the part of *hosts* to these parasitic crustaceans, and the animals which are called upon to willingly, or unwillingly, act this part belong chiefly to the same class to which the parasites themselves belong and to the fishes. Fishes appear to be special favourites in this respect. Scarcely any part of a fish's body is free from the intrusion of these unwelcome or (in some cases, perhaps) welcome visitors; they are found running over the skin of the fish, they adhere to the fins, the gills and gill covers, they are found on the lips, the tongue, and the roof and sides of the throat, in the nasal fossæ, and in other and even more strange and out-of-the-way places on or about the body of the fish.

The degree of parasitism varies greatly even amongst closely-allied species; in some cases the relationship of the crustacean to the fish is decidedly that of a parasite, but in other cases it would be inaccurate to describe the association of the one with the other as truly parasitic. Sometimes, however, it is more convenient to use the terms *parasitic*, *parasite*, etc., in this broad sense, even though it may not in some cases be strictly correct, in order to avoid the complications that would arise by any attempt to describe, in a strictly accurate manner, the various degrees of relationships that exist between crustaceans and the fishes which have become their hosts; it is in this wider sense that such terms are used in the present paper.

The study of the parasitic crustacea is in some respects more difficult, if also more interesting, than that of the species which live under normal

conditions. Their structure has, because of their parasitic habits, become more or less altered, and, in consequence of this, the forms which not a few of them have assumed are greatly at variance with those which usually characterise free-living species. Some of these parasitic crustaceans have assumed forms so strangely abnormal and grotesque that even the most experienced naturalists have failed to recognise their relationship to the crustacea, and only by the study of their development and life-history have their true affinities been determined.

Amongst crustacean parasites of fishes, the Copepoda is the group that is probably the most largely represented, and I therefore propose to devote the chief portion of this paper to the consideration of this group; a few of the Isopoda and Amphipoda that have been observed are also referred to.

A small list of Copepod-parasites of fishes was published in Part III. of the *Twelfth Annual Report of the Fishery Board for Scotland* (1894). Since that time other species, besides those enumerated in that list, have been obtained, and during the past summer special attention has been devoted to the study of these organisms, with the result that several interesting forms have now to be added to the copepod fauna of Scotland.

The crustacean parasites mentioned in the sequel have for the most part been obtained on fishes captured in the Firth of Forth, in the Firth of Clyde, or in some other part of the sea around the Scottish coasts; a few interesting species have been obtained on fishes brought to the Fish Market at Aberdeen, and with regard to these I am unable to state the place where the fishes were captured, though I believe that those on which the parasites were found were in most instances taken somewhere off the coast of Scotland.

In the preparation of these notes various works on parasitic Copepoda have been consulted, and in this respect the late Dr Baird's *History of the British Entomostraca* is still indispensable. Several valuable papers on the copepod parasites of fishes have in recent years been published by Dr. Basset-Smith, R.N., one of the latest being *A Systematic Description of Parasitic Copepoda found on Fishes, with an enumeration of the known species.* *

The classification of Gerstäcker† is that which Dr. Basset-Smith has chiefly followed in his *Systematic Description*, and as it appears to be the one which is now generally adopted, the species mentioned in the present paper are arranged as far as possible in conformity with it.

Mr. Andrew Scott, assisted by Mrs. Scott, has prepared the drawings necessary for the elucidation of the species recorded here.

I have also to acknowledge my indebtedness to Mr. Peter Jamieson, the Laboratory Assistant, for help in the collection of specimens for this paper.

The COPEPOD Parasites of Fishes.

According to recent classification the Copepod parasites of fishes have been arranged under seven families, the names and arrangement of which are as follows :—Ergasilidæ, Caligidæ, Dichelestidæ, Philichthyidæ, Lernæidae, Chondracanthidæ, and Lernæopodidæ. The Philichthyidæ is the only one of the seven families which does not seem to be represented in the British fauna; but even this family may also yet be found to have representatives amongst the Copepod fauna of our seas.

* *Proc. Zool. Soc. London*, April 1899.

† *Vide* Copepoda in Bronn's "Klassen und Ordnungen des Thierreichs," v. i. (1866-74).

Fam. ERGASILIDÆ.

This family has apparently only two, or at most three, genera belonging to it, but the number of species is about twenty-two. All the species are small and easily overlooked. I have notes of two species each of which represents a separate genus.

Genus *Bomolochus*, Nordmann (1832).

Bomolochus soleæ, Claus.

1864. *Bomolochus soleæ*, Claus, Zeitschrift für Wissenschaft. Zool., vol. xiv., p. 374, Pl. XXXV.
1893. *Bomolochus soleæ*, T. Scott, *Eleventh Ann. Rep. Fish. Board for Scot.* (III.), p. 212, Pl. V.

This copepod is found occasionally on the back of the common sole, *Solea vulgaris*. Those I have observed were on the coloured side, and were not easily noticed. It is a species that may readily escape detection, and may therefore be more frequent than it at present appears to be. I have found *Bomolochus soleæ* on *Solea vulgaris* captured near Grimsby, and also on the same species of fish captured in the Firth of Forth and in the Firth of Clyde. The specimen described and figured in the *Fishery Board Report*, referred to above, is from the Firth of Forth.

Genus *Thersites*, Pagenstecher (1861).

Thersites gasterostei, Pagenstecher. (Pl. V., figs. 1–7.)

1861. *Thersites gasterostei*, Pagenstecher, Arch. f. Naturg. vol. xvii., p. 118, Pl. VI., figs. 1–9.
1863. *Ergasilus gasterostei*, Kröyer, Naturh., Tidsskr., R. 3, vol. ii., p. 223, Pl. XII., fig. 2.
1892. *Thersites gasterostei*, Canu, Copep. du Boulonnais, p. 245, Pl. XXIII., figs. 13–18.
1899. *Ergasilus gasterostei*, Basset-Smith, Proc. Zool. Soc. London (April 1899), p. 444.

Description of the Female.—The cephalothorax is considerably dilated on the dorsal aspect, so that when viewed from the side or from above it appears to be almost spherical; abdomen short (fig. 1). The specimen represented by the figure carried two ovisacs, which were large in proportion to the animal.

The antennules (fig. 2) are very short, moderately stout, and five-jointed; the two end joints are each rather shorter than any of the other three, and they are all sparingly setiferous; the formula shows approximately the proportional lengths of all the joints—

Proportional lengths of the joints, $\frac{16 \cdot 10 \cdot 11 \cdot 7 \cdot 8}{1 \cdot 2 \cdot 3 \cdot 4 \cdot 5}$
Numbers of the joints,

The antennæ are short and stout, and are each provided with a strong terminal claw (fig. 3).

The mandibles appeared to have a bilobed-pectinated biting part, but owing to the structure of the Copepod these organs were somewhat difficult to dissect out; the maxillæ were also somewhat obscure.

The anterior foot-jaws (1st maxillipedes) are simple, and provided with one or two small setæ. The posterior foot-jaws (2nd maxillipedes) have an enlarged basal part to which is articulated a more slender curved arm bearing a few strong apical spines (fig. 4).

The first three pairs of thoracic feet have both branches apparently three-jointed, but the outer branches are rather shorter than the inner ones (fig. 5 represents the first pair). In the fourth pair, the first two joints of the outer branches appear to be coalescent, so that they seem to be only two-jointed, but the inner branches, as in the preceding three pairs, are three-jointed (fig. 6). The abdomen is short but moderately stout; in the adult female it seems to be shorter than it really is, from being partly hidden by the enlarged cephalothorax; the first abdominal segment is rather broader than the next and is longer than the entire length of all the others; the caudal segments are short and the principal furcal setæ are stouter and much more elongated than those adjacent.

Length about ·8mm. ($\frac{1}{30}$ of an inch).

Habitat.—Found adhering to the inner surface of the gill-covers of a three-spined stickleback (*Gasterosteus aculeatus*), captured in Sinclair Loch, Barra, Outer Hebrides, in May 1894; and on another taken in the River Forth, near Alloa, February 1896. The same species of Copepod was also found on the inside of the gill-covers of a fifteen-spined stickleback (*Gasterosteus spinachia*), captured in Loch Etive in May 1896.

Remarks.—This Copepod has by some writers been ascribed to the genus *Ergasilus*, but it does not fit in very readily with the characters of that genus. The typical *Ergasilus* has the body moderately elongated, whereas in the present form the body is, except for the short abdomen, not only short but almost spherical in general appearance. I therefore agree with Dr. Canu's restoration of Pagenstecher's generic name, *Thersites*, for this species.

Fam. Caligidæ.

The Caligidæ contain a much larger number of genera and species than any other of the seven families amongst which the Copepod parasites of fishes have been arranged. According to Dr. Basset-Smith, the number of genera belonging to the Caligidæ is (exclusive of *Nogagus*) 25, while the number of species is 124. Two of the genera—*Caligus* and *Lepeophtheirus*—contain 49 and 26 species respectively, or 75 in all, which is fully three-fifths of the total number belonging to the whole family. As for *Nogagus*, no female Copepod which could satisfactorily be ascribed to this genus has ever been observed, and students of the Copepoda are now of opinion that the various "species" of *Nogagus* are really the males of species belonging to other genera, *i.e.*: *Pandarus*, *Dinematura*, etc.

Steenstrup and Lütken, in their valuable memoir on Copepod parasites of fishes,* include under *Caligus* the species belonging to that genus and also those belonging to *Lepeophtheirus*. The various forms belonging to these two groups have a close resemblance to each other, not only in their general appearance, but also in their structure; but there are two characters by which the species belonging to the one group are easily separated from those belonging to the other; these characters are the presence or absence of *sucking disks* or *lunulæ* on the frontal plates, and the unifid, or bifid form of the appendages described by Steenstrup and Lütken as *palpi*. In *Caligus*, *lunulæ* are always present and the *palpi* are unifid, in *Lepeophtheirus*, on the other hand, *lunulæ* are always absent and the *palpi* are bifid. The importance to be attached to these differences is, of course, very much a matter of opinion, and *Lepeophtheirus* will by authors take its place as a "genus" or be reduced to a synonym of *Caligus*, according to the value they place on these differences. In the present paper I follow Dr. Baird and Dr. Basset-Smith in regarding the two as distinct genera.

* Særskilt aftrykt Kongl. Danske Vidensk-Selsk. Skrifter, 5te Række Naturh. o. Mathemat. Afdel. 5te Bind.

Genus *Caligus*, O. F. Müller (1785).

(1) Abdomen in the female composed of one segment.

The general outline of the body is more or less oval and greatly depressed. *Lunulæ*, or "sucking disks," are present on the frontal plates; the *palpi* are thorn-like, and end in a single point. Fourth pair of thoracic feet one-branched.

Caligus curtus, Müller. (Pl. V., figs. 8–12.)

1785. *Caligus curtus*, Müller, Entomostraca, p. 130, Pl. XXI., fig. 1.

1850. *Caligus mülleri* (?) and *diaphanus*, Baird, Brit. Entom., pp. 271 and 269.*

The *Caligus mülleri* and probably also *Caligus diaphanus* of Dr. Baird's "Entomostraca" are, according to Steenstrup and Lütken, synonymous with *Caligus curtus* (Müller), and this seems to be also the opinion of recent writers on this group of Copepods. In view of this, however, it may be noted that in most, if not in all, the other species of *Caligus* and *Lepeophtheirus* the male is usually, and sometimes considerably, smaller than the female; but the *Caligus diaphanus* of Baird, which is considered to be the male of *Caligus curtus* (Müller), is frequently very much larger than the ovigerous females of that species. Some species are, however, subject to more variation than others, and this may account, partly at least, for the difference in size.

Caligus curtus is not only a common species, but may be found on various kinds of fishes, including several species of *Gadus*, ling, hake, torsk, plaice, and other flat-fishes; the grey and the long-nosed skate, etc.

A certain amount of variableness in size and general appearance is observable amongst the different specimens that have been examined; but the difference was not greatly in excess of that which has been noticed in specimens belonging to some of the other species.

Caligus rapax, M.-Edw. (Pl. V., figs. 13–19.)

1840. *Caligus rapax*, M.-Edw., Hist. Nat. Crust., vol. iii., p. 453, Pl. XXXVIII., fig. 9.

1850. *Caligus rapax*, Baird, op. cit., p. 270, Pl. XXXII., figs. 2 and 3.

This, like *Caligus curtus*, is one of the more common species, but it differs from most other *Caligi*, at least to some extent, in being much more commonly obtained as a *free-swimmer* in the open sea. We frequently find *Caligus rapax* in tow-net gatherings, collected both at the surface and at the bottom. Ovigerous females are, however, not so commonly met with as males and young females. But though it is apparently more of a free-swimmer in its habits than others, and also perhaps because of this, *Caligus rapax* is found on even a larger variety of fishes than *Caligus curtus*. There is scarcely a fish in our seas on which this *Caligus* may not at one time or another be found.

Like *Caligus curtus*, this species also exhibits a certain amount of variation in the forms and sizes of males and ovigerous females, but it is, if anything, more marked in the latter. Some females with ova from a large grey skate varied from 5·1mm. to 6·1mm. in total length; while the length of the abdomen in the same specimens varied from 0·7mm. to 1·1mm. Some difference was also observed in these specimens in the breadth of the last segment of the thorax. Two apparently adult males obtained on

*For other synonyms, see Basset-Smith's "Systematic Description" already referred to.

the same fish with the females show a difference of at least 0·7mm. in total length. These differences are more clearly exhibited in tabular form as follows :—

VARIATION IN SIZE OF *Caligus rapax* FROM *Raia batis*.

	Female Specimens.				Male Specimens.	
	No. 1.	No. 2.	No. 3.	No. 4.	No. 1.	No. 2.
Total length from forehead to the end of the caudal furca, .	5·2mm.	5·1mm.	5·2mm.	6·1mm.	3·8mm.	4·5mm.
Length of abdomen, .	·7mm.	·8mm.	·8mm.	1·1mm.	...	...
Breadth of last thoracic segment, . . .	·8mm.	·8mm.	1·0mm.	1·1mm.	...	...

Though the length of these female specimens varied to the extent of a full millimetre, there appeared to be no structural difference of any importance. Perhaps it may be noted in passing that fig. 2, Pl. XXXII., in Dr. Baird's work represents a young female and not a male—an error due no doubt to an oversight on the part of the artist.

(2) Abdomen composed of two segments.

Caligus diaphanus, Nordmann. (Pl. V., figs. 20–25.)

1832. *Caligus diaphanus*, Nord., Mikrog. Beiträge, ii., p. 26 (*non C. diaphanus*, Baird).
1894. *Caligus isonyx*, T. Scott, *Twelfth Ann. Rept. Fish. Board for Scot.* (III.), p. 310.
1896. *Caligus diaphanus*, Basset-Smith, Journ. M. B. Assoc., Plymouth, p. 156.

Both male and female of this species have the abdomen two-jointed. The species is a small one; the female specimen represented by the drawing (fig. 20) is only about 4·4mm. in length; the abdomen is moderately elongate, being about one-fourth of the entire length of the animal; the last abdominal segment is small but quite distinct. The lateral margins of the last thoracic segment are convexly and evenly rounded, but posteriorly this segment is abruptly truncate, and is also not much longer than the abdomen.

The antennæ (posterior antennæ) are moderately short and armed each with a strongly but evenly hooked claw. The mandibles are slender and elongated, and the last joint is distinctly serrated on the inner edge (fig. 22). The posterior foot-jaws are robust, and furnished with strong terminal claws; the penultimate joint is also produced near the base of the inner margin into a stout triangular tooth (fig. 24). The sternal fork has moderately long and slightly divergent branches (fig. 23). The apices of the *palpi* are single and spine-like.

The fourth pair of thoracic feet are moderately stout; the branches are distinctly three-jointed, and carry five moderately long setæ (fig. 25). There is also on the last thoracic segment what appears to be a fifth pair of feet, each of which consists of a minute sub-triangular one-jointed appendage bearing a few small setæ. The caudal segments are very short.

In the male the abdomen consists of two sub-equal segments; the last thoracic segment is narrow and not much wider than the abdomen. The antennæ appear to differ slightly from those of the female, especially in possessing a supplementary tooth near the base of the terminal claw.

Habitat.—Our specimens of this species were obtained in the gill-cavity of *Trigla gurnardus* from the Firth of Forth, the Firth of Clyde, and at Aberdeen Fish Market; also on *Trigla lineata* from the Clyde, and on a specimen of *Trigla hirundo* in the collection of fishes in the Laboratory at Bay of Nigg.

Genus *Lepeophtheirus*, Nordmann (1832).

The species belonging to this genus are, in their general form, very similar to *Caligus*, but, as already said, there are no *lunulæ* on the frontal plates, and the *palpi* are furcate instead of being simple and spine-like. Six or seven species belonging to this group have been obtained on fishes examined by me.

(1) Abdomen composed of one segment.

Lepeophtheirus pectoralis (Müller). (Pl. V., figs. 26–31.)

1776. *Lernea pectoralis*, Müller, Zool. Dan., p. 41, Pl. XXXIII., fig. 7.
1850. *Lepeophtheirus pectoralis*, Baird., Brit. Entom., p. 275, Pl. XXXII., fig. 10.

The specimen of *Lepeophtheirus pectoralis* represented by the figure on Plate V. (fig. 26) measures about five millimetres (one-fifth of an inch) in length; the cephalic shield is nearly circular; the last segment of the thorax is large and sub-quadrate, but its lateral margins are very slightly curved; the abdomen is short, and somewhat constricted near the middle, so that in certain positions it appears as if it were composed of two segments; the caudal segments are very short.

The antennæ (posterior antennæ) are provided with strong terminal hooked claws. The mandibles, which are small and slender, have the inner edge of the distal joint distinctly toothed (fig. 28). The posterior foot-jaws are strong, and they are armed with stout, curved terminal claws. In the sternal fork the branches become dilated in the middle then taper to a point at the end (fig. 29). The *palpi* are furcate.

The fourth pair of thoracic feet have the branches two-jointed, and are provided with three terminal setæ, and there is also a small seta or spine on the outer distal angle of the first joint. The fifth pair, which consist of small but comparatively broad lamelliform plates, provided with two or three minute terminal hairs, are situated behind the bases of the ovisacs, and are therefore easily missed.

The male (fig. 27) is little more than half the size of the female, but the cephalic shield is proportionally larger; the last segment of the thorax is small. In the male antennæ the basal joint is rather more dilated than in that of the female, while the terminal claw is smaller and more strongly hooked.

This is one of the more common and easily identified species of *Lepeophtheirus*. The peculiar form of the sternal fork, the small fourth pair of thoracic feet, and the short abdomen seem to be fairly good specific characters. Slight differences in the general form of the animal and in some of its structural details are occasionally observed, especially in specimens from different fishes, such as the plaice and the flounder.

Habitat.—Found for the most part adhering to the underside of the pectoral fins of plaice, *Pleuronectes platessa*, from the Firths of Forth and Clyde, and at the Fish Market at Aberdeen; on flounders, *Pleuronectes flesus*, from the Firth of Forth and the Moray Firth; and on common dabs, *Pleuronectes limanda*, from the Firth of Forth.

Lepeophtheirus nordmanni (M.-Edwards). (Pl. V., figs. 32–37.)

1840. *Caligus nordmannii*, M. Edw., Hist. Nat. Crust., vol. iii., p. 455, No. 10.

1850. *Lepeophtheirus nordmannii*, Baird, Brit. Entom., p. 275, Pl. XXXII., fig. 10.

This is a moderately large species; the specimen represented by the figure measures about half-an-inch in length (12 mm.). The cephalic shield is of an oval form and is distinctly larger than the last segment of the thorax. The abdomen is short (fig. 32).

The mandibles in this species are long and slender, but the last joint is comparatively short, and has a short serrated margin (fig. 34). The branches of the sternal fork are long and somewhat slender; they are also to some extent divergent (fig. 35). The posterior foot-jaws are large and armed with long terminal claws.

The branches of the fourth pair of the thoracic feet are three-jointed, and are provided with five setæ, three of which spring from the apex of the last joint, and one from the outer distal angle of the first and second joints (fig. 37). The fifth pair, which have a sub-triangular outline, are broadly foliaceous.

Habitat.—On a short sun-fish, *Orthagoriscus mola*, landed at Aberdeen Fish Market on 1st September 1899. One specimen only was obtained.

Remarks.—The abdomen of this specimen of *Lepeophtheirus nordmanni* obtained by me appeared to be rather more elongated than that which is represented in Dr. Baird's figure. He also describes the branches of the sternal fork as "sharp-pointed," but in our specimen the branches, though slender, are somewhat blunt at the ends.

Lepeophtheirus hippoglossi (Kröyer). (Pl. V., figs. 38–42; Pl. VI., figs. 1–2.)

1838. *Caligus hippoglossi*, Kröyer, Naturh. Tidsskrift, R. i., vol i., p. 625, Pl. VI., fig. 3.

1850. *Lepeophtheirus hippoglossi*, Baird, Brit. Entom., p. 276, Pl. XXXII., figs. 1–2.

The ovigerous female represented by the drawing (Pl. V., fig. 38) was rather more than half-an-inch in length (about 13·5 mm.). The cepalic shield was large and of an oval outline, but the last segment of the thorax was comparatively small and narrow, and rather longer than broad. The abdomen was small, and slightly constricted near the posterior end. The caudal segments were very short.

In this species the mandibles are long and slender, though scarcely so much so as those of *Lepeophtheirus nordmanni*. The sternal fork differs from that of any of the other *Lepeophtheirus* recorded here in having each of the two branches distinctly biped (fig. 2, Pl. VI.). The fourth pair of thoracic feet have the branches three-jointed and furnished with four setæ, three at the apex and one on the outer distal angle of the second joint (fig. 41, Pl. V.). The fifth pair consists of small triangular plates situated behind the bases of the ovisacs.

In the adult male (fig. 39, Pl. V.) the last thoracic segment is very small, and the fifth pair of feet are more or less exposed. The male is also much smaller than the female, being scarcely half as long. In the male the antennæ appear to be also somewhat different from those of the female, the basal joint is more dilated and the terminal claw is more strongly hooked.

Habitat.—Taken on the backs of large halibut, *Hippoglossus vulgaris*, landed at Aberdeen Fish Market during the summer and autumn of 1899.

This, like other species of *Lepeophtheirus*, exhibits a certain amount of variation, but full-grown specimens may usually be distinguished by the form of the ventral fork. *L. hippoglossi* appears to be found principally on the halibut, and is not uncommon. I have found a slightly immature specimen on a torsk, *Brosmius brosme*, in Aberdeen Fish Market, but probably it had been accidentally transferred to the torsk by contact of that fish with a halibut.

Lepeophtheirus thompsoni, Baird. (Pl. V., figs. 43–45.)

1850. *Lepeophtheirus thompsoni*, Baird, op. cit., p. 278, Pl. XXXIII., fig. 2.

1899. *Lepeophtheirus thompsoni*, Basset-Smith, Proc. Zool. Soc. Lond. (April 1899), p. 455.

This is a smaller species than the last; the female represented by the drawing (fig. 43) is about one-third of an inch (8·5 mm.) in length. In this species the last segment of the thorax is sub-quadrate in outline, rather longer than broad, and increases slightly in width posteriorly. The abdomen is elongated, and its thickness increases to a slight extent for a short distance beyond the middle, when a slight decrease begins and where also a small constriction is sometimes visible. The caudal segments are very short.

The antennæ of *Lepeophtheirus thompsoni* are armed with stout and strongly-hooked claws (fig. 45). The mandibles are somewhat similar to those of *Lepeophtheirus pectoralis*. The sternal fork is also somewhat like that of the same species, but the branches of the fork are scarcely so much dilated (fig. 44). The fourth pair of thoracic feet are distinctly three-jointed, and moderately stout; they each bear three terminal setæ, and a seta or spine at the outer distal angle of the first and second joints, but that on the first joint is very minute. The fifth pair, which are oval in outline, are very small and situated below and slightly anterior to the bases of the ovisacs.

Habitat.—On the gills of turbot, *Bothus maximus*, captured in the Firth of Forth, the Firth of Clyde, and on the gills of turbot examined in the Fish Market at Aberdeen.

Lepeophtheirus stromi, Baird. (Pl. VI., figs. 3–8.)

1847. *Caligus stromii*, Baird, Trans. Berw. Nat. Club (1847).

1850. *Lepeophtheirus stromii*, Baird, Brit. Entom., p. 274, Pl. XXXII., figs. 8 and 9.

We have obtained this copepod on salmon, *Salmo salar*, captured in Montrose Bay and Bay of Nigg (Aberdeen). I have seen no specimens from the Firth of Forth or the Firth of Clyde, but they will doubtless be found on salmon captured within these estuaries as well as elsewhere.

Lepeophtheirus stromi has the abdomen proportionally rather more elongated than that of *L. thompsoni*, and the ovisacs are usually very long and slender. The dorsal surface in this species has a curious metallic lustre, different from most of the others of the same genus. Males appear to be comparatively scarce.

The branches of the sternal fork are moderately short and stout, and are broadly rounded at the ends (fig. 5). The fourth pair of thoracic feet have the branches three-jointed and provided with four short setæ; the outer distal angle of the first joint is apparently not provided with a seta in this species, but is simply rounded. The fifth pair of feet are broadly

sub-triangular, and have three small terminal hairs arranged as shown on the figure.

Figure 8 represents a young specimen newly hatched.

Lepeophtheirus pollachii, Basset-Smith. (Pl. VI., figs. 9–15.)

1896. *Lepeophtheirus pollachius*, Basset-Smith, Ann. and Mag. Nat. Hist. (6), vol. xviii., p. 12, Pl. IV., fig. 1.

1899. *Lepeophtheirus pollachii*, Basset-Smith, Proc. Zool. Soc., Lond. (April 1899.)

The length of the specimen represented by the drawing (fig. 9) is about three-tenths of an inch (7·5mm.). The cephalic shield is sub-orbicular, but the last segment of the thorax is sub-quadrate, and is nearly as large as the cephalic shield; this segment also slightly increases in width towards the posterior end. The abdomen is about as long as the last thoracic segment, and tapers somewhat towards the extremity. The caudal segments are of moderate size.

The antennæ are armed with moderately large terminal claws strongly hooked at the end. The mandibles are elongate and slender; the last joint, which is short and about as broad as the preceding one, is serrated on the inner edge. The sternal fork has moderately short and simple divergent branches, and resembles the letter V inverted (fig. 13). The posterior foot-jaws are stout, and provided with strong terminal claws. The branches of the fourth pair of thoracic feet, which are three-jointed, are moderately elongated and slender; three spiniform setæ spring from the end of the third joint, while the first and second joints are each provided with a seta or spine on the outer distal angle (fig. 15). The fifth feet are small, sub-quadrate, and bear each three small apical setæ.

The male is about as long as the female, but the last segment of the thorax is very small; the abdomen is composed of two sub-equal segments (fig. 10). The antennæ and the posterior foot-jaws of the male also differ to some extent from those of the female.

Habitat.—Our specimens were obtained adhering to the inside of the mouth of a lythe, *Gadus pollachius*, caught in the salmon-nets in Bay of Nigg, Aberdeen, June 22nd, 1899.

This species appears to develop moderately long ovisacs.

(2) Abdomen composed of two segments.

Lepeophtheirus (?) *obscurus* Baird. (Pl. VI., figs. 16–19.)

1850. *Lepeophtheirus obscurus*, Baird, Brit. Entom., p. 277, Pl. XXXII., fig. 11.

1896. *Caligus obscurus*, Basset-Smith, Ann. and Mag. Nat. Hist. (6), vol. xviii., Pl. IV., fig. 2; Journ. M. B. Assoc. Plymouth (1896), p. 157.

1899. *Lepeophtheirus obscurus*, Basset-Smith, Proc. Zool. Soc. Lond. (April 1899), p. 456.

The length of the female specimen represented by the drawing (fig. 16) is about one-fourth of an inch (8·2mm.). The cephalic shield is sub-orbicular, but rather longer than broad. The last segment of the thorax is about two-thirds of the length of the cephalic shield, and of a sub-cylindrical form, and its posterio-lateral angles are produced into boldly-rounded lobes. The abdomen is in length equal to about three-fourths of the length of the last segment of the thorax, and is distinctly jointed near the posterior end. The caudal segments are very small.

The antennæ are armed with large and strongly-hooked terminal claws

(fig. 17). The mandibles somewhat resemble those of *Lepeophtheirus pectoralis*. The sternal fork, which appears to vary to some extent, has moderately stout branches; these branches are somewhat dilated in the middle and slightly divergent (fig. 18). The branches of the fourth pair of thoracic feet appear to be only two-jointed, like those of *L. pectoralis*; each branch is, for the most part, provided with five setæ arranged as shown in the drawing (fig. 19), but some specimens want the marginal seta on the end joint; the seta at the outer distal angle of the first joint is a very small one. The fifth pair are broadly foliaceous, and situated beneath and slightly anterior to the basal part of the ovisacs.

No males have been observed.

Habitat.—On the gills, inside gill-covers, and under the pectoral fins of brill, *Bothus rhombus*, captured in the Firth of Forth and the Firth of Clyde.

It is very doubtful if the copepod described here, or the one described under the same name by Dr. Basset-Smith, be the *Lepeophtheirus obscurus* of Dr. Baird's monograph. The copepod described by Dr. Baird as *Lepeophtheirus obscurus* was a male, and was probably, as he himself suggests,* a male of *Lepeophtheirus hippoglossi*. Figure 39, Plate V., of the present paper represents an adult male of *Lepeophtheirus hippoglossi*, and if Dr. Baird's figure of *L. obscurus* be compared with it the resemblance between them will be seen to be very close. Moreover, Dr. Baird, in describing *Lepeophtheirus obscurus*, says:—"Abdomen small; not more than one-third the size of last ring of thorax. . . . Sternal fork well developed, each branch being bifurcated, the inner branch being much smaller than the other." All this, as well as the remaining parts of the description, agrees exactly with what we see in the male of *Lepeophtheirus hippoglossi*.

The *Lepeophtheirus* from the brill, described in the preceding notes, resembles *L. thompsoni* to some extent, and may probably be only a form of that species. It seems to differ, however, in having a somewhat longer abdomen; in having the abdomen more distinctly segmented; in the sternal fork being rather different in form; and in the form of the fifth thoracic feet being slightly different.

Dr. Basset-Smith describes the sternal fork of his *Lepeophtheirus obscurus* as having bifurcating branches,† but in some other respects as closely resembling *L. thompsoni*. If the bifurcate form of the sternal fork be a character more or less constant in Dr. Basset-Smith's specimens, they are likely to be different from that which I have recorded, and that notwithstanding their otherwise close similarity to *Lepeophtheirus thompsoni*, for, as already pointed out, though the form of the sternal fork in my specimen varies to some extent, in none of those examined has it been observed to have bifurcated branches.

The male specimen described by Dr. Baird as *Lepeophtheirus obscurus* may, in view of what has been stated by Dr. Basset-Smith, be after all a distinct species, the female of which is the form recorded by that author, and, if that be so, we have here another example of the want of uniformity between the sexes of the same species, which is sometimes observed amongst the parasitic Copepoda. This disparity between the sexes, however, is, I think, of less frequent occurrence amongst *Caligus* or *Lepeophtheirus* than it is amongst some of the other groups. If, for example, the female *Caligus* or *Lepeophtheirus* be distinguished by a short or a long abdomen, the male of the same species to which the female belongs has usually, though perhaps not in every case, the abdomen

* Brit. Entom., p. 363.

† *Journ. M. B. Assoc., Plymouth* (April 1899), p. 158.

correspondingly short or long. Now, in regard to the forms under consideration, it will be observed that the females of Dr. Basset-Smith's *Lepeophtheirus obscurus* have the abdomen moderately long and two-jointed, whereas Dr. Baird's male has a "small abdomen" consisting of one segment. It may be that, notwithstanding this discrepancy, the two forms belong to the one species; but I am inclined to think that Dr. Baird's own suggestion—that his *Lepeophtheirus obscurus* is the male of *Lepeophtheirus hippoglossi*—is after all the correct explanation of the difficulty.

Genus *Trebius*, Kröyer (1838).

This genus resembles *Lepeophtheirus* in its general configuration, in the absence of *lunulæ* on the frontal plates and in the possession of bifurcated *palpi*. On the other hand, the most distinctive and obvious difference between *Trebius* and *Lepeophtheirus* is that in the former the fourth pair of thoracic feet are furnished with two branches instead of only one branch, as in the case of the latter.

The only species belonging to this genus is the one described below.

Trebius caudatus, Kröyer. (Pl. VI., figs. 20–26.)

1838. *Trebius caudatus*, Kr. Naturh. Tidsskrift (1838), R. i., vol. ii., p. 30, Pl. I., fig. 4.

1850. *Trebius caudatus*, Baird, op. cit., p. 280, Pl. XXXIII., figs. 3, 4.

In the female of this species the cephalic shield, which is about as long as the entire remaining portion of the thorax, is nearly oval, and rather longer than broad. The last segment of the thorax is sub-cylindrical, its breadth being equal to about four-fifths of the length; the posterio-lateral angles are rounded and fringed on the posterior aspect with three small but stout spines. The abdomen is long and slender, and composed of two segments; a slight constriction is also observable towards the distal end of the second segment, which has in some specimens the appearance of an additional joint. The caudal segments are small.

The antennæ (posterior antennæ) are armed with strongly-hooked terminal claws (fig. 22). The mandibles are somewhat similar to those of *Lepeophtheirus*, but the end-joint appears to be rather stouter than the preceding one, and is distinctly serrated on the inner margin (fig. 24). The *palpi* are bifurcated, but the inner branch of each *palpus* is rather shorter than the other. The sternal fork is small, and the branches are simple and comparatively short (fig. 23). In the fourth pair of thoracic feet the basal joints are stout and comparatively short; both of the three-jointed branches are also short, but the outer ones are armed exteriorly with five moderately stout marginal spines, and interiorly with plumose marginal setæ. The inner branches are also setiferous, but they want the exterior marginal spines.

The male (fig. 21), which is scarcely half the length of the female, has the fourth thoracic segment very small. The abdomen consists of two segments, and is of moderate length; the two segments are somewhat unequal, the first being rather shorter than the other. The caudal segments are slightly longer than those of the female.

The length of the female specimen figured is about four-tenths of an inch (10mm.). In another specimen of about the same length the abdomen measured 3mm.; while in a somewhat larger one, the entire length of which was 11mm., the abdomen measured 4mm. in length, or fully two-thirds the entire length of the animal.

Habitat.—On the grey skate, *Raia batis*, from the Firth of Forth, the Firth of Clyde, and the Moray Firth, and on specimens of the same fish brought to the Fish Market at Aberdeen. I found *Trebius* also on a specimen of thornback, *Raia clavata*, captured in the Firth of Clyde on April 22nd, 1897.

Genus *Dinematura*, Latreille, 1829 (modified by Burmeister, 1831).

Burmeister objected to the form of the word "*Dinemoura*" used by Latreille, and changed it to *Dinematura*. This change in the form of Latreille's name appears now to be generally accepted and used.

Dinematura producta (Müller). (Pl. VI., figs. 27–31.)

1785. *Caligus productus*, Müller, Entom., p. 132, Pl. XXI., fig. 3.
1850. *Dinemoura lamnæ*, Baird, op. cit., p. 286, Pl. XXXV., fig. 7.

The *Dinemoura* (*Dinematura*) *lamnæ* of Baird's monograph, now identified as the *Caligus productus* of Müller, has been obtained by me on one or two occasions during the past autumn on young porbeagle sharks, *Lamna cornubica*, caught in the North Sea, and landed at the Fish Market at Aberdeen. The larger specimens of *Dinematura* measured fully four-fifths of an inch (20mm.) in length, exclusive of the ovisacs, which were long and slender (fig. 27). One of the porbeagle sharks, on which we obtained several specimens, was about three feet three inches in length.

The antennæ of *Dinematura producta* (fig. 28) are armed with powerful hooked terminal claws. The mandibles are elongated and very slender (fig. 29). The anterior foot-jaws (fig. 30) are moderately stout, and each terminates in a hook-like apex; a short but stout and slightly curved appendage also springs from the inner aspect, and near the distal end of the penultimate joint. The posterior foot-jaws are short and stout, and somewhat rudimentary in structure.

The first three pairs of thoracic feet are two-branched and somewhat similar to those usually observed in the Caligidæ, but the fourth pair are large and foliaceous. The caudal segments are composed of broad quadrangular plates, the width of which is equal to about two-thirds of the length; their outer margin is nearly straight, but the inner is gently and evenly convex; the apex is subtruncate, and bears three small setæ, while a fourth seta springs from a notch near the distal end of the outer margin (fig. 31). No males have been observed.

The characters by which this species may be distinguished include, amongst others, the form of the dorsal plates, the abruptly-hooked antennæ, the structure of the *palpi* and of the anterior foot-jaws, the form of the fourth pair of thoracic feet, and of the caudal furca.

One of the specimens obtained at the Fish Market at Aberdeen measured three inches (75mm.) from the forehead to the ends of the long ovigerous tubes.

Genus *Echthrogaleus*, Steenstrup and Lütken (1861).

Echthrogaleus coleoptratus (Guérin). (Pl. VI., fig. 32.)

1817. *Dinematura coleoptrata*, Guérin, Icon. d. reg. Animal, vol. iii., Pl. XXXV., fig. 6.
1850. *Dinemoura alata*, Baird, op. cit., p. 285, Pl. XXXIII., fig. 8.

One or two specimens of this curious little species were found adhering

to the fins of a porbeagle shark brought to the Fish Market at Aberdeen.* The specimen figured (fig. 32) measured from the front of the head to the end of the caudal furca about seven-sixteenths of an inch (11mm.), and the ovisacs, which were slender, were fully four times the length of the body—about two and one-quarter inches altogether.

The dorsal plates are adorned with small impressed circular marks, forming a more or less regular pattern, and this, together with the form of the plates, gives to them a fairly close resemblance to the elytra of certain coleopterous insects. This species appeared to be less frequent than the *Dinematura producta* already recorded.

Genus *Cecrops*, Leach (1816).

Cecrops latreillii, Leach.

1816. *Cecrops latreillii*, Leach, Ency. Brit. Suppl., vol. i., p. 20, figs. 1–5.
1850. *Cecrops latreillii*, Baird, op. cit., p. 293, Pl. XXXIV., fig. 1.
1892. *Cecrops ldtreillii*, A. Scott, Trans. Nat. Hist. Soc. Glasgow, vol. iii., Part III., p. 266.

Several specimens of *Cecrops* were obtained on a short sun-fish, *Orthagoriscus mola*, captured in the Firth of Forth in October 1890. They were found adhering to the gills of the fish, and do not appear to be very uncommon on this species of *Orthagoriscus*. One or two specimens were taken from the gills of a sun-fish captured 14 miles east from Lerwick, Shetland, on 17th August 1893. The specimens recorded by Dr. Baird, which were obtained on sun-fishes captured at different parts of the coasts of England and Ireland, were also taken from the gills.

Genus *Pandarus*, Leach (1816).

The principal generic characters of *Pandarus* are, according to Dr. Baird, as follows:—(1) Several pairs of lamellar, elytraform appendages. (2) All the thoracic feet fitted to a certain extent for walking and armed near their extremities with short and thick hooks. There appears to be but one British species of *Pandarus*, viz., *P. bicolor*. The *Pandarus boscii*, described by Dr. Leach and Dr. Baird, is now considered to be a form of *P. bicolor*; indeed, Dr. Baird himself suggests that *P. boscii* is "only a variety" of the more common species.

Pandarus bicolor, Leach. (Pl. VI., figs. 33–38.)

1816. *Pandarus bicolor*, Leach, Ency. Brit. Suppl., vol. i., p. 405, Pl. XX., figs. 1–2.
1850. *Pandarus bicolor*, Baird, op. cit., p. 288, Pl. XXX, fig. 10.

Several specimens of *Pandarus bicolor* have been obtained during the past autumn on sharks which have been brought to Aberdeen Fish Market, and known by the name of tope or topers, *Galeus canis*. The parasites were found for the most part adhering to the fins of the topers, and less frequently on other parts of the fish.

The specimen figured measured about two-fifths of an inch in length, exclusive of the ovisacs, which were long and slender (fig. 33). The dorsal surface was adorned with dark chocolate-coloured blotches arranged somewhat as shown in the drawing.

The female antennæ are small and somewhat rudimentary; they are

* The specimens of *Echthrogaleus coleoptratus* recorded by Dr. Baird were obtained by Dr. Johnston also from a porbeagle shark captured in Berwick Bay.

each provided with a large gibbous, cushion-like appendage which seems to arise from the base of the antenna, and to project considerably forward on the under side (fig. 35). These appendages may probably be used as "sucking discs," seeing that the other means of attachment possessed by this copepod do not appear to be very greatly developed. The *palpi* are small but moderately stout and somewhat cone-shaped. The appendages, which appear to be the posterior foot-jaws, are greatly dilated, clumsy, and unshapely, with a broad cushion-like extremity.

The four pairs of thoracic feet are all two-branched; the first pair has the outer branches two-, and the inner apparently only one-jointed; the inner branches are also somewhat abnormal in shape. The second and third pairs have both branches moderately short and stout and composed of two joints, while in the fourth pair both branches appear to be only one-jointed.

On one of the topers examined at the Aberdeen Fish Market in October last I obtained a specimen—a male—of a *Nogagus*-like copepod, which I am inclined to consider as being the male of our *Pandarus*. (Figure 34 represents the specimen referred to). In some of its structural details this *Nogagus* closely resembles *Pandarus bicolor*. The antennæ are provided with dilated cushion-like appendages somewhat like those of the *Pandarus*, but they differ in being armed with terminal claws (fig. 36). The *palpi* are somewhat similar, and so also are the exterior foot-jaws. The posterior foot-jaws differ in possessing a distinct though small terminal claw. All the four pairs of thoracic feet are each two-branched, each branch is two-jointed, and the branches are provided with densely plumose hairs.

Nogagus, as a genus of copepods, is now to a large extent, if not altogether, obsolete. All the species of which it is composed are represented only by males. Several of these males have already been identified as the males of species belonging to other genera, and those which have not yet been satisfactorily disposed of will, it is believed, be also found to be the males of other species. The *Nogagus*-like form referred to as found on the toper in the Aberdeen Fish Market, though differing considerably in general appearance from *Pandarus bicolor*, coincides so closely with it in several of its structural details, that there seems to be little doubt of its being really the male of the *Pandarus*.

Habitat.—From what is stated both by Dr. Baird and Dr. Basset-Smith, it would appear that *Pandarus bicolor* is not confined to *Galeus canis** though it seems to be more frequent on that fish. The parasite has been recorded by these authors as occuring also on *Carcharius glaucus*, and *Scyllium catulus* (the Greater Spotted Dog-fish).

Genus *Lemargus*, Kröyer (1838).

The thoracic feet in *Lemargus* differ from those of *Cecrops* in being for the most part broadly foliaceous, and forming at the same time branchial appendages. The intermediate body-segments are smaller than either the anterior cephalic shield, or the posterior lamelliform dorsal plates. There appears to be but one British species of *Lemargus*.

Lemargus mu icatus, Kröyer. (Pl. VI., figs. 39–42.)

1838. *Lemargus muricatus*, Kr. Naturh. Tidsskrift, R. i., vol. i, p. 488, Pl. V., fig.

1850. *Lemargus muricatus*, Baird, op. cit., p. 294, Pl. XXXIV., figs. 3–4.

1892. *Lemargus muricatus*, A. Scott, Trans. Nat. Hist. Soc. Glasgow, vol. iii., Pl. III., p. 266.

* This is the same as *Squalus galeus*, Linn., mentioned by Dr. Baird, and *Galeus vulgaris* of Day.

A few specimens of *Lemaryus muricatus* were obtained on a large sunfish, *Orthagoriscus mola*, captured in the Firth of Forth in October 1890. My son (Mr. A. Scott) describes the copepods as burrowing in hollows formed in the flesh of the fish behind the anal fin; they were not, as in the case of *Cecrops*, found on the gills. T. Edward has recorded this parasite from the Moray Firth, but it does not appear to have been very frequently observed.

Lemaryus has three-jointed, moderately long and well developed antennules. The antennæ are short, but they are armed with stout and strongly-hooked terminal claws. The mandibles are long and stylet-shaped, and minutely serrated at the distal end (fig. 40). The anterior foot-jaws are very small and armed with short but broad and sharp-pointed terminal claws, finely serrated on the inner edges (fig. 41). The posterior foot-jaws form strong and powerful grasping appendages, as shown in the figure (fig. 42).

The thoracic feet are all two-branched, but the first and second pairs are not so broadly foliaceous as the others, and approach more to the normal type of feet observed in this group of parasites. In the first pair the outer branches are considerably longer than the inner ones; but the branches of the second pair, which are short and two-jointed, are sub-equal in length. In the third and fourth pairs both branches consist of broad, one-jointed plates, almost devoid of spines or setæ of any kind. In the fifth pair one of the branches forms a large lamelliform plate, but the other branch is very small and bears at the apex a few minute spines.

Fam. Dichelestidæ.

This family includes, according to Dr. Basset-Smith, about 15 genera, but only three or four of them are represented in the British seas, and two are noticed in the present paper.

Genus *Clavella*, Oken (1815)

Clavella hippoglossi, Kröyer. (Pl. VII., figs. 1–6.)

1838. *Clavella hippoglossi*, Kr., Naturh. Tidsskrift, R. i., vol. i., p. 196, Pl. II., fig. 3.

This, which is so far the only species of *Clavella* I have observed, has the body very slender and of a reddish colour, the ovisacs are very elongated and of a colour similar to that of the body. We have found a number of these on the gills of large halibut, *Hippogossus vulgaris*, brought to the Fish Market at Aberdeen; they resemble the gill filaments of the fish so closely, both in form and colour, that they are easily missed. It was chiefly by accident they were first observed by us, from noticing a portion of their reddish thread-like ovisacs projecting beyond the ends of the gill filaments.

The head in *Clavella hippoglossi* is small and rounded; the neck is comparatively narrow and indistinctly segmented; the genital segment is elongated, narrow, and cylindrical, and the abdomen is extremely short. The posterio-lateral angles of the genital segment are produced into small rounded processes, about equal to the length of the abdomen, so that the posterior end has a trilobed appearance.

The entire length of the specimen figured (fig. 1), exclusive of the ovisacs, is about the seven-twentieths of an inch (9mm). The following are the measurements of another and rather larger specimen:—Entire length of the body, 9·5mm.; length of head and neck combined, 1·5mm.;

length of genital segment, 8mm.; length from forehead to end of ovisacs, 23mm.

Clavella hippoglossi has well developed and moderately stout five-jointed antennules, which are sparingly setiferous (fig. 2). The antennæ are moderately large and provided with powerful terminal hooks suitable for grasping (fig. 3). The mandibles are small, elongated and tapering, and armed with a few small teeth at the distal end of the inner margin. The maxillæ, or *palpi*, are very small, but comparatively stout, and are provided with two or three special tooth-like processes. The foot-jaws are elongated and slender. Both pairs of the thoracic feet are two-branched and both branches appear to be two-jointed (fig. 6). No males have been observed.

Genus *Cycnus*, M.-Edwards (1840).
Syn. *Congericola*, Van Beneden (1854).

The species belonging to *Cycnus* are in general appearance somewhat similar to *Clavella*; they may be distinguished, however, by the possession of four pairs of two-branched thoracic feet, instead of only two pairs, but these thoracic feet are not so fully developed as in *Clavella*. I have only observed one species of *Cycnus*, viz.:—

Cycnus pallidus (Van Beneden).

1854. *Congericola pallidus*, Van Ben., Bull. Acad. Roy. Belg, vol. 21, pt. ii., p. 583.
1896. *Cycnus pallidus*, Basset-Smith, Journ. M. B. Assoc. (Feb. 1896), p. 159.

About 30 specimens, counting adult, immature and damaged, of this species were obtained on the gills of a large *Conger vulgaris* sent from the Clyde by Mr. F. G. Pearcey, naturalist on board the "Garland." The conger was captured at Station IX., near the mouth of the estuary, on December 13th, 1899. In form and colour these parasites closely resemble pieces of the gill-filaments, and may therefore be readily overlooked. The specimens I observed were found to adhere very firmly to the gill-filaments, so much so that several specimens were damaged in the course of removing them.

None of the specimens measured reached to quite four millimetres; one specimen was about 3·7mm. in length, exclusive of ovisacs, and from the forehead to the end of the ovisacs the length was 8·2mm.; another specimen, measured in the same way, reached to 3·8mm. and 9·3mm. respectively; the same specimens measured about ·7mm. in width.

Fam. Lernæidæ.

This family appears to contain a strangely mixed lot of parasitic copepods. The adult females belonging to some of the genera in this group have a somewhat abnormal appearance; development in their case is retrogressive, and to such an extent that in some instances nearly all traces of the characters which distinguish these copepods from the other orders of crustacea are obliterated. *Lernæa branchialis* may be cited as an example of extreme degradation. On the other hand, there are some species which have rather an elegant shape and possess copepod characters of a more distinctive form.

Three genera of the *Lernæidæ* are represented in the present paper.

Genus *Lernæenicus*, Lesueur. (1824).
Syn. *Lerneonema*, M.-Edw. (1840).

Lernæenicus sprattæ (Sowerby). (Pl. VII., figs. 7–10.)

1806. *Lernæa spratta*, Sowerby, Brit. Miscell., vol. ii., p. 17, Pl. LXVIII.
1850. *Lerneonema spratta*, Baird, op. cit., p. 341, Pl. XXXV., fig. 10.
1876. *Lernæenicus sprattæ*, Richiardi, Atti. della Soc. Tosc., vol. iii.
1891. *Lerneonema spratta*, T. Scott, *Ninth Ann. Rep. Fish. Board Scot.*, Pt. III., p. 306.

In August 1890 my son, Mr. John Scott, observed a sprat, or a small herring, he was not sure which, swimming about in one of the Leith Docks with a *Lernæenicus* attached to one of its eyes, but he failed to capture it. My son, Mr. Andrew Scott, has obtained the species in the Morecambe Bay district of Lancashire and has sent me one or two sprats for examination, having the parasite *in situ*, and the drawing on Plate VII. represents one of these sprats with the parasite attached to its eye (fig. 7). One of the sprats sent me for examination has no fewer than three specimens of *Lernæenicus* attached to one of its eyes. Figure 8 represents a *Lernæenicus*, which my son dissected, from the eye of a sprat. This specimen exhibits the thorax as having a moniliform structure a short distance posterior to the head. The head is provided with the barbed processes peculiar to these organisms. The head is also furnished with distinct though small antennules, but it is doubtful if these can be of any use to the animal; the antennules are represented by figure 7. The antennæ, though small, have the end-joints chelæform and well adapted for grasping (fig. 10). The length of the specimen figured is about seven-tenths of an inch (18mm.), exclusive of the ovisacs, and if the length of the ovisacs be added the total length reaches to about 43mm., or one inch and three-fourths.

Genus *Lernæa*, Linn. (1767).

This genus contains what appear to be the most degraded of the copepod parasites of fishes. It requires some stretch of the imagination to associate the large, mature, and bizarre-looking female *Lernæa* with the elegant and agile *Cyclops*, yet in their early stages of growth the two are not very dissimilar. *Lernæa* was placed by Linnæus amongst the Mollusca in the Class Vermes.

Lernæa branchialis, Linn. (Pl. VII., figs. 11 and 12.)

1767. *Lernæa branchialis*, Linn., Syst. Nat., 12th ed., p. 1092.

This well-known fish parasite is moderately common. We have records of it from various places around the Scottish coasts, as the Firths of Forth and Clyde, and the Moray Firth. Also on haddocks landed at the Fish Market at Aberdeen.

The species appears to vary to some extent. The specimen represented by figure 11 is probably the more common form; it is distinguished by having a moderately long neck, similar to that shown by Dr. Baird.* Another form with a much shorter neck is represented by figure 12.

Lernæa minuta, n. sp. (Pl. VII., fig. 13.)

Description of the Female.—Length of the specimen figured, about three-tenths of an inch (8mm.). Cephalic lobe somewhat dilated, horns

* Brit. Entom., Pl. XXXV., fig. 12.

not greatly developed. Thoracic feet, four pairs, small but distinct, and situated immediately behind the cephalic lobe. Neck short and moderately slender. Genital segment, moderately large and slightly sigmoid. Ovisacs elongated, slender, and twisted, as in *Lernœa branchialis*.

Habitat.—On the gills of the speckled goby (*Gobius minutus*).

Remarks.—Our superintendent, Dr. T. Wemyss Fulton, while examining some small fishes sent to the Laboratory from the Solway during November 1899, observed a small *Lernœa* on the gills of a specimen of *Gobius minutus*. This he kindly handed over to me along with a considerable number of specimens of the same species of goby. On making a careful examination of all these specimens—about 134 in number—three more specimens of the *Lernœa* were obtained; making in all four specimens of this parasite from 135 fishes, or about 3 per cent.

The average length of the specimen figured, exclusive of ovisacs, is a little over 7mm.

I have not been able to find any previous record of this small *Lernœa*, and have therefore described it as a new species under the name of *Lernœa minuta*.

Genus *Hœmobaphes*, Steenstrup and Lütken.

Hœmobaphes cyclopterinus (Fabr.). (Pl. VII., fig. 14.)

1780. *Lernœa cyclopterina*, Fabr., Fauna Grœnl., p. 337.
1861. *Hœmobaphes cyclopterina*, Stp. and Lütk., Bidrag til Kundskab, p. 405, Pl. XIII., fig. 30.
1891. *Hœmobaphes cyclopterina*, T. Scott, *Ninth Ann. Rept. Fish. Board Scot.*, Pt. III., p. 310.

I have only seen two specimens of this curious Lernæan, and both were found on the gills of the pogge, *Agonus cataphractus*. One was obtained at Dunbar by Mr. Jamieson, Laboratory Assistant, in April 1891, on the gills of a pogge taken from the stomach of a cod; the other was taken also from the gills of a pogge captured by the "Garland" in the Firth of Forth in February 1892. This specimen was recorded in the Annals of Scottish Natural History for April of the same year. It is represented in the present paper by figure 14 on Plate VII.; the neck and upper part of the thorax of this specimen was accidentally damaged.

I have recently examined a large number of pogges without finding a single example of this *Hœmobaphes*; probably the species is a rare one.

Hœmobaphes ambiguus, sp. n. (Pl. VII., fig. 15.)

A *Hœmobaphes*-like parasite was found on the gills of a specimen of the spotted dragonet, *Callionymus maculatus*, captured in the Solway in October 1899.

This parasite differs from *Hœmobaphes cyclopterinus* in having a very short neck, and in the abdominal portion of the genital segment being more produced; moreover, this produced part is compressed and somewhat dilated at the end, the margins are somewhat irregular in outline, and the lateral lobes are moderately prominent (fig. 15). Only one ovisac is shown in the figure; the other was accidentally destroyed.

The entire length of the specimen figured is about the seven-twentieths of an inch (11·5mm.).

I have been unable to find any published description of this form; and as it agrees with *Hœmobaphes* in some of its more prominent characters, I have decided to regard it for the present as "new."

Fam. CHONDRACANTHIDÆ.

Genus *Oralien*, Basset-Smith (Proc. Zool. Soc. Lond., April 1899, p. 489).
Syn. *Lernentoma* (pars.), Baird, Brit. Entom., p. 329.

This genus has been established by Dr. Basset-Smith for *Lernæa asellina*, Linn. (*Lernentoma asellina*, Baird), because of the marked difference in the arrangement of the cephalic appendages. In the typical *Chondracanthus* these appendages are arranged in more or less proximity, but in *Lernæa asellina* the head, which is rounded anteriorly and provided with antennules and antennæ as well as lateral lobe-like projections, is produced behind into a cylindrical and moderately elongated neck, at the base of which, where the neck joins the thorax, is situated the mouth and the several mouth organs. By this arrangement a considerable distance intervenes between the antennal appendages and the mouth parts. But besides this departure from the arrangement of the parts usually observed in the genus *Chondracanthus*, the general appearance of the animal also exhibits a marked difference from that of the other species belonging to that genus.

Oralien asellinus (Linn.). (Pl. VII., figs. 16–18.)

1761. *Lernæa asellina*, Linn., Fauna Suec., 2101.
1838. *Chondracanthus triglæ*, Kr. Naturh. Tidsskrift, R. i., vol. ii., p. 135, Pl. III., fig. 3.
1850. *Lernentoma asellina*, Baird, op. cit., p. 329, Pl. XXXV., fig. 4.

In this species the front part of the head is enlarged by the development of a lobe-like projection on each side; this part is usually buried deeply in the tissues of the fish. The antennules are short, moderately stout, simple appendages. The mandibles, which are somewhat similar to those of *Chondracanthus*, are stout and falcate, and their convex margins are fringed with short but moderately stout spines (fig. 18). The maxillæ, maxillipedes, and other appendages are somewhat similar to those of *Chondracanthus cornutus*.

The size of specimens varies to some extent; the more usual dimensions, however, seem to be as follows:—Length, exclusive of ovisacs, about 8 mm.; length from front of head to end of ovisacs, about 12 mm. A specimen from a common gurnard, *Trigla gurnardus*, measured only 5·5mm. in length of body and 8·5mm. to the extremity of the ovisacs.

I have obtained the species on the gills of gurnards, plaice, halibut, and other fishes captured on all parts of the Scottish coasts examined by us.

It is of interest to note that in the various works on the copepod parasites of fishes which I have consulted no two authors agree in their figures of this species. It may be that there is more than one species included in *Chrondracanthus asellinus*, or the differences referred to may be due to the variableness of the species.

Genus *Chondracanthus*, De la Roche (1811).
Syn. *Lernentoma* and *Chondracanthus*, Baird.

In this genus the head, though distinct, is not separated to any great extent from the thorax. The antennules are usually more or less conspicuous in front of the head, and these and the antennæ are in close proximity to the mouth organs. The genital segment is more or less cylindrical, as in *Chondracanthus cornutus*, or constricted, as in

Chondracanthus soleæ. Ten species are recorded in the sequel, but one of them is somewhat doubtful and apparently undescribed.

Chondracanthus cornutus (Müller). (Pl. VII., figs. 19–31.)

1776. *Lernæa cornuta*, Müller, Zool. Dan., vol. i., pl. 33, fig. 6.
1850. *Lernentoma cornuta*, Baird, op. cit., p. 328, Pl. XXXV., fig. 2.

This species, as represented by the figure in Dr. Baird's "British Entomostraca," has the genital segment of a cylindrical form and without any marked constriction in the middle; and in his description of the species Dr. Baird makes no allusion to any constriction of the posterior "two-thirds" of the thorax; had any constriction been observed, as conspicuous as it is, for example, in *Chondracanthus soleæ* or *Chondracanthus flurœ*, he would very likely have referred to it. Moreover, the figures of the same species by Nordmann* and Kröyer,† though showing a slight constriction of the thorax, agree fairly well with that of Dr. Baird.

Specimens agreeing in their general appearance with Dr. Baird's figure of *Chondracanthus cornutus*, except that they exhibit a slight constriction, as shown in the figure by Nordmann, have been found on the plaice, *Pleuronectes platessa*, and the common flounder, *Pleuronectes flesus*. I find on the plaice two forms of the *Chondracanthus*; the more common one (represented by figure 19) is the smaller of the two, and is also proportionally broader. The specimen of this form represented by the figure referred to measured 5·8mm., exclusive of ovisacs. The antennules of this specimen were considerably dilated, and showed little structure. The antennæ were furnished with strongly-hooked terminal claws, while the mandibles were moderately stout and tapered towards the end, where they became somewhat attenuated. The anterior foot-jaws had a moderately stout basal part, but the end-joint was more slender and was serrated on the inner edge (fig. 23).

The male of this form, which is very small, is represented by figure 24; it measured scarcely the half of a millimetre in length; the abdomen, which appeared to be distinct from the thorax, was more or less segmented.

A specimen of the less common and more elongated form is represented by figure 27; it measured nearly 7 millimetres in length. The posterior portion of the thorax in this form is long and narrow, and slightly constricted in the middle; the antennules (fig. 28) appear to be scarcely so robust as in the smaller form, but the mandibles and other appendages do not seem to differ much.

Habitat.—The smaller form has been obtained on plaice from the Firth of Forth, Firth of Clyde, Moray Firth, and at Aberdeen Fish Market. The larger form was found on the gills of a plaice in the collection of fishes in the Laboratory at Bay of Nigg, but the locality where this plaice came from is not stated on the label.

Chondracanthus annulatus, Olsson. (Pl. VII., figs. 46–51.)

1867. *Chondracanthus annulatus*, Olsson, Prodr. Faunæ Copep. Parasit. Scand., vol. v., p. 30, Pl. II., figs. 13–15.

A number of specimens of this *Chondracanthus* were obtained from the gills of a large grey skate, *Raia batis*, caught in the North Sea and landed at the Fish Market at Aberdeen, June 30th, 1899.

In this species the body is elongate, moderately narrow, and cylindrical in form; it is about four times longer than broad, and not much

*Mikrogr. Beitr., vol. ii., Pl. 9, fig. 5.
†Naturh. Tidsskr., R. iii., vol. 2, Pl. 13, fig. 7 (1864).

compressed. The head is well defined, the neck is short, and the posterior part of the thorax is slightly constricted in the middle. The abdomen is very short, and so are the posterio-lateral processes of the thorax. As the abdomen and lateral processes are about the same length, they give to the posterior end of the thorax a more or less trilobed appearance (fig. 46). The specimen represented by the figure is about 14mm. ($\frac{1}{2}\frac{1}{0}$ of an inch) in length, exclusive of ovisacs, and from the front part of the head to the extremity of the ovisacs the length is about 2 inches.

The antennules in the female are very short and considerably dilated; the mandibles differ very little from those of *Chondracanthus cornutus*. The two pairs of thoracic limbs are both very short.

A male specimen, which is represented by figure 47, measured about 3 millimetres in length; its antennules were smaller than those of the female, and were rather more setiferous. The antennæ were short, but they were armed with strong, though somewhat short, terminal claws.

Chondracanthus clavatus, Basset-Smith. (Pl. VII., fig. 35–37.)

1896. *Chondracanthus clavatus*, Basset-Smith, Ann. and Mag. Nat. Hist. (6). vol. 18, p. 13, Pl. V., fig. 6.

In this species the thorax increases in width towards the posterior end; the posterio-lateral appendages are of moderate length, as shown by the figure (fig. 35). The antennules are considerably dilated and somewhat like those of *Chondracanthus cornutus* in their general appearance. The mandibles and the other appendages are also nearly the same as in that species, but the posterio-lateral thoracic processes are considerably longer, being equal to about one-sixth of the entire length of the animal.

The average length of the specimens I have measured is 6·5mm., but some are found a little smaller and some larger. The ovisacs are also not very elongate; the largest specimens I have observed scarcely reached a total length (including ovisacs) of 10mm.

Habitat.—On the gills of lemon soles, *Pleuronectes microcephalus*, caught in the Firth of Forth, in the Firth of Clyde, and on other parts of the Scottish coast. The male of this species is very like that of *Chondracanthus cornutus*.

Chondracanthus soleæ, Kröyer. (Pl. VII., figs. 41–45.)

1838. *Chondracanthus soleæ*, Kr., Naturh. Tidsskr., R. i., vol. i., p. 139, Pl. III.

1864. *Chondracanthus soleæ*, Kr., op. cit., R. iii., Pl. II., p. 330.

The specimens of *Chondracanthus* which I record under this name of Kröyer's were found on black soles, *Solea vulgaris*, captured in the Firth of Clyde in October and December 1899, and on turbot, *Bothus maximus*, captured in the Firth of Forth in July 1892. Kröyer obtained his specimens also from black soles. The species is distinguished by its comparatively small and robust form, by the comparatively elongated posterior thoracic appendages, and by the elongated posterio-lateral processes of the thorax. Moreover, the posterior portion of the thorax is distinctly constricted in the middle, as shown by the drawing (fig. 41). In comparing the antennules and antennæ, the mouth organs, and other appendages of this form with those of *Chondracanthus cornutus*, it is found that, though there is a certain amount of resemblance between them, differences are observable, which, taken in combination with the marked difference in the general appearance of the animals, present as good grounds for separating *Chondracanthus soleæ* from *Chondracanthus*

cornutus as there are for separating *Chondracanthus clavatus* from the same species.

The male of *Chondracanthus soleæ* resembles also in some respects the male of *Chondracanthus cornutus*, but appears to differ in the form of the antennules and of the second pair of thoracic feet (figs. 44, 45); the antennules are considerably dilated and of a somewhat triangular form; and the second pair of feet have a sub-quadrate outline.

A moderately large female, obtained on a specimen of *Solea vulgaris* captured in the Clyde, measured about 8·5mm., exclusive of the ovisacs, which were as long as the specimen itself. In this specimen the lateral processes at the posterior end of the thorax were a millimetre in length, which was somewhat less than in some of the other specimens examined.

Chondracanthus flurœ, Kröyer. (Pl. VII., figs. 32–34.)

1864. *Chondracanthus flurœ*, Kr., op. cit., R. iii., vol. ii., pp. 323 and 330, Pl. XIII., fig. 6.

Kröyer obtained this species from the long rough dab, *Platessa limandoides* (Bl.), or *Drepanopsetta platessoides*, Fabr., as this fish is now called. Specimens of *Chondracanthus flurœ* have been obtained on long rough dabs captured in the Firth of Clyde; some of them were taken on specimens captured at Station III. (Kilbrennan Sound) in December last. This parasite has not been observed by us on any other kind of fish. *Chondracanthus flurœ*, like the one last described, has the posterior portion of the thoracic segment in the female distinctly constricted in the middle, but it is more robust, and the thoracic limbs, as well as the posterio-lateral processes, are short. Kröyer's description of the species, which accords very well with the Clyde specimens, is as follows:—"Forma crassa robustaque, latitudine fere dimidiam longitudinis partem obtinente, capite mediocri, latiore quam longiore, subsemilunato; annulis thoracicis omnibus perbene distinctis, latioribus quam longioribus, primo secundoque insequentibus multo angustioribus. Antennæ anterioris paris latitudine capitis paulo breviores, basi sejunctæ, articulo terminali conico, seta apicis instructo. Membra annuli thoracici primi et secundi minuta, eadem ferme longitudine ac latitudine, vix vel parvum furcata. Processus annuli thoracici quarti posteriores ipso annulo breviores (tertia quartave parte), crassi subconici. Abdomen dimidiam processuum longitudinem superius conicum, biarticulatum. Ovaria externa gracilia, elongata?" *

This species is smaller, but comparatively more robust, than the one last recorded. The specimen represented by the drawing measures about 4·7mm. in length; while the length of a somewhat larger specimen is 5·5mm., exclusive of ovisacs, and from the forehead to the end of the ovisacs the length is fully 10·5mm.

Chondracanthus merluccii, Holten.

Chondracanthus merluccii, Holten, Mem. Soc. Hist. Nat. Copenhag., vol. v., Pl. III., fig. 2.

1892. *Chondracanthus merluccii*, T. Scott, *Tenth Ann. Rept. Fish. Board for Scot.*, Pt. III., p. 262.

1896. *Chondracanthus merluccii*, Basset-Smith, Journ. M. B. Assoc. Plymouth, p. 161.

This is a moderately common parasite on the hake, *Merluccius vulgaris*. I find it most frequently clinging to the roof and sides of the mouth, and

* Naturh. Tidsskr., R. III., Bd. 2, p. 330 (1864).

sometimes on the under side of the tongue and the inside of the gill-covers. *Chondracanthus merluccii* differs from the other species in having, besides its usual thoracic limbs, a pair of moderately long appendages near the middle of the posterior portion of the thorax, and also in the posterio-lateral processes being considerably elongated. The mandibles, which are distinctly toothed on the upper margin, and the other cephalic appendages are all more or less similar to the same appendages in other species of *Chondracanthi.*

A female specimen of average size measured about half an inch in length, exclusive of ovisacs. The males are very small, and sometimes more than one of them may be observed sticking on a female. The species varies to some extent both in its general outline and in the proportional lengths of the various appendages.

Chondracanthus lophii, Johnston.

1836. *Chondracanthus lophii*, Johnston, Loud. Mag. Nat. Hist., p. 81, fig. 16.
1850. *Lernentoma lophii*, Baird, op. cit., p. 330, Pl. XXXV., fig. 3.

This is one of the more common of the copepod parasites of fishes; it seems to be to a large extent peculiar to the angler, *Lophius piscatorius*, and is usually found adhering to the inside surface of the gill-pouches. A considerable percentage of the anglers captured by the "Garland" are more or less infested with this copepod. I have records of it from the Firth of Forth, the Firth of Clyde, and other parts of the Scottish coasts. The oviferous tubes are slender, usually elongated, and more or less twisted.

Chondracanthus zeus, De la Roche. (Pl. VIII., fig. 1.)

1811. *Chondracanthus zei*, De la Roche, Nouv. Bull. des Sc. de la Soc. Philom., vol. ii., p. 270, Pl. II., fig. 2.
1850. *Chondracanthus zei*, Baird, op. cit., p. 327, Pl. XXXV., fig. 1.

In this species the dorsum is ornamented with a number of processes, which gives the specimens a bizarre appearance not usually observed amongst the *Chondracanthi.*

I obtained a specimen of *Chondracanthus zeus* on the gills of a John Dory, *Zeus faber*, caught in the Firth of Forth in 1891; this specimen is recorded in Part III. of the *Tenth Annual Report of the Fishery Board for Scotland* (1892). A second specimen was obtained in the Firth of Forth in 1896, also on the gills of a John Dory. *Chondracanthus zeus* has also been obtained in the Firth of Clyde, on a John Dory, captured there by the "Garland."

The length of the specimen represented by the figure was about half an inch, but the species varies to some extent both in size and ornamentation.

Chondracanthus limandæ, Kröyer. (Pl. VII., figs. 38–40.)

1864. *Chondracanthus limandæ*, Kr., op. cit., R. iii., vol. ii., pp. 322 and 330, Pl. XIV., fig. 2.

Kröyer obtained this species on *Platessa limanda* (*Pleuronectes limanda*, Linn), the common dab. I have obtained on two different specimens of the common dab what appears to be the same species of copepod. The common dab from which the specimen represented by the

drawing (fig. 38) was obtained was captured in the Firth of Clyde in 25-30 fathoms, November 1899. A second specimen, exhibiting even a closer resemblance to the figure, was obtained on a common dab taken by the "Garland" at Station VII. in the Moray Firth on January 24th of the present year (1900).

This species is moderately robust; the first thoracic segment is very short; the second is of moderate size, and has on each side a slightly elevated and broadly rounded knob—"annulo secundo duobus tuberculis humeralibus praèdito magnis." * The posterior portion of the thorax is more or less distinctly constricted, so that this portion of the thorax appears as if it were divided into two slightly unequal parts. The thoracic limbs are more rudimentary than those of *Chondracanthus cornutus*; in that species the second pair are distinctly bifid, but in the present form they are not so, or they show at most the merest trace of bifurcation, agreeing in this respect also very closely with Kröyer's description—"Membra annuli thoracici primi et secundi latiora quam longiora semilunaria, haud furcata, posterius par priori multo majus." The posterio-lateral projections of the thorax are comparatively short and stout; the abdomen is very short and composed of two segments.

The specimen represented by the drawing is about 5mm., exclusive of the ovisacs, which are about the same length, giving a total length of about 10mm.

The male is very small; one which I measured was only 0·65mm. (scarcely one-thirty-eighth of an inch) in length.

Chondracanthus ornatus, sp. n.

I have recently obtained on the gills of specimens of the spotted dragonet, *Callionymus maculatus*, a *Chondracanthus*-like copepod, which appears so far to be undescribed. The female of this copepod viewed from above has a general outline closely similar to that of an equilateral triangle, the bluntly-rounded head forming the apex and the truncate posterior end the base; the front of the head is indistinctly tri-lobed, one bluntly-rounded lobe being in the centre, and projecting slightly in front of the two lateral lobes, which are also bluntly rounded; the neck connecting the head with the thorax is very short; along each side of the thorax (forming the sides of the triangle) there are three or four more or less distinct tubercles†, and a series of three similar tubercles extends along the middle of the dorsum; the posterior tubercle of the middle series stands well up, but each of the other two stands at a slightly lower elevation than the one immediately behind; the abdomen is exceedingly small and inconspicuous. The ovisacs are of moderate length and stoutness, like those of *Chondracanthus limandæ*.

The length of the more typical of my female specimens is as follows: From forehead to the posterior end of body, 5mm. (one-fifth of an inch); from forehead to the end of the longest of the two ovisacs, 11·5mm. (nearly half an inch); the width of the thorax at the posterior end is just a little over 5mm., so that the body of the animal, as I have already said, has a general outline closely similar to that of an equilateral triangle.

The male is very small; it scarcely reaches to 0·6mm. ($\frac{1}{40}$ of an inch) in length. I have not had time to get drawings of this interesting species prepared, but it has such a characteristic form that the description of the female I have given, together with the *habitat* of the species, should facilitate its identification. I have obtained the species on the

* Kroyer, Naturh. Tidsskr., R. III., Bd. 2, p. 230 (1864).

† The arrangement and position of these lateral tubercles seems to vary slightly in different specimens; the description refers to the *general appearance* as seen from above.

gills of *Callionymus maculatus* from the Firth of Clyde, collected in 1899, and from the Moray Firth, collected at Station VII. on January 24th, 1900. From the ornate character of the species I have called it *Chondracanthus ornatus*.

Fam. Lernæopodidæ.

This, the last of the series of seven families into which the parasitic copepods of fishes have been divided, contains ten genera, and five of these are represented in the present paper, viz.:—*Thysanote*, *Charopinus*, *Lernæopoda*, *Brachiella*, and *Anchorella*.

Genus *Thysanote*, Kröyer (1863).

Thysanote impudica (Nordmann). (Pl. VIII., figs. 2–5.)

1832. *Brachiella impudica*, Nord., Mikrog. Beitr., vol. ii., p. 92, Pl. VIII., fig. 3.
1899. *Thysanote impudica*, Basset-Smith, Proc. Zool. Soc. Lond. (April 1899), p. 497.

I ascribe to this species a small *Brachiella*-like parasite found on the gills of a specimen of *Trigla hirundo* (the red gurnard) in the collections of fishes in the Laboratory of the Fishery Board for Scotland at Bay of Nigg, Aberdeen. I have not been able to ascertain definitely where the fish was captured, but it was probably taken either at the mouth of the Forth estuary or in the Firth of Clyde.

Genus *Charopinus*, Kröyer (1863).

Charopinus dalmanni (Retzius). (Pl. VIII., figs. 6–10.)

1831. *Lernæa dalmannii*, Retz., Froriep's Notizen, vol. xxix., p. 617, Pl. VI., fig. 5.
1863. *Charopinus dalmannii*, Kr., Naturh. Tidsskr., R. iii., p. 280, Pl. XIV., fig. 6.
1878. *Stylophorus hypocephalus*, Hesse, Ann. Sci. Nat. (6), vol. viii., art. 15, p. 1.
1891. *Charopinus dalmannii*, T. Scott, Ninth Ann. Rept. Fish. Board for Scot., Pt. III., p. 310.

In this species the head, or anterior portion, of the thorax is ventrally and abruptly deflexed, and at the angle of the thorax thus formed there springs from each side a long, moderately slender and indistinctly annulated appendage, which becomes dilated and lunuleform at the apex. These two lunuleform apices, which, though not actually joined, fit very closely together, are buried in the tissues of the fish infested by this parasite. These appendages, by which the parasite anchors itself to the fish, are usually described as the second maxillipedes. The posterior portion of the thorax becomes gradually enlarged towards the distal end, and assumes a more or less clavate form; two moderately long and slender processes spring from the ventral aspect and just in front of the ovisacs; the two sides of the posterior portion of the thorax curve slightly inwards near the base, and each terminates in a small lobe. The abdomen, which is situated between and slightly in front of these lobes, is almost obsolete. The ovisacs are of moderate length, and saccate, and the ova are small and arranged in multiserial order. The following measurements are taken from a specimen of average size:—Length of second

maxillipedes, 22mm.; length of head and thorax (anterior to the angle from whence the second maxillipedes spring), 9mm.; length of posterior portion of thorax, 15mm.; length of ovisacs, 20mm.; length of the ventral thoracic appendages, 10mm.; total length from the apices of second maxillipedes to the end of ovisacs, 55mm. (nearly 2¼ inches).

The male of this large copepod scarcely reaches beyond two millimetres in length.

The antennules in the female are apparently three-jointed, and are moderately stout. The antennæ are short, stout, and feebly clawed (fig. 8). The mandibles, which are of moderate length and somewhat slender, are serrated at the distal end of the inner margin (fig. 9). The anterior foot-jaws (maxillipedes) are stout and feebly clawed.

In the male the thorax and abdomen (fig. 7) are more or less segmented); and the maxillipedes are short and stout, and, being armed with strong terminal claws, form powerful grasping organs.

Habitat.—In the nasal fossæ (or spiracles) of the grey skate, *Raia batis*. All the specimens we have obtained have been found in the nasal fossæ of the grey skate. *Charopinus dalmanni* appears to be moderately common on the large skate brought to the Fish Market at Aberdeen; sometimes two and three specimens have been found in the same spiracle of the skate examined in the market. I have also taken this species from a grey skate captured at the mouth of the Forth estuary.

Charopinus dubius, sp. n.

I record provisionally under this name a *Charopinus* which has been obtained adhering to the gills and gill-arches of the cuckoo ray, *Raia circularis*, Couch. The fishes from which these copepods were obtained were captured in the Firth of Clyde during December 1899. No specimens of this copepod have so far been observed in the spiracles of the cuckoo ray.

This *Charopinus* resembles more or less closely the *Charopinus* of the grey skate, and may only be a form of that species. The following points, however, deserve notice:—

Charopinus dubius is distinctly smaller than *Charopinus dalmanni*. The second maxillipedes are more slender in proportion to their length, and they are joined to each other at the apex by small horn-coloured plugs, which unite to form a thin circular horny disk, hollow in the middle and with the margins slightly reflexed. This disk is usually buried in the hard substance of the gill-arches, and is difficult to dissect out while retaining its union with the maxillipedes. The ovisacs are also rather more elongate and slender.

The most obvious difference between *Charopinus dalmanni* and the present form, other than that of size, is the character of the apices of the second maxillipedes; the difference here is very distinct and must of itself be held as alone of specific value if the differences recognised by Kröyer are to be considered valid. According to that distinguished observer, the more important specific characters by which *Charopinus dalmanni* (Retz.) and *Charopinus ramosus*, Kr., are distinguished, are taken chiefly from the form assumed by the apices of the second maxillipedes. Kröyer's definitions of these species are as follow:—

"*Charopinus dalmannii.*

*Laminæ cartilagineæ, quibus affigitur femina, semilunares."

*Naturh. Tidsskr., R. 3, Bd. 2 (1863–64), p. 362.

"*Charopinus ramosus.*

Laminæ, quibus affigitur femina, exterius in ramos binos elongatos graciles, crucem fere, efficientes productæ."

My specimens differ from both of these species in the important characters specially referred to; they also differ in their habitat. *Ch. dalmanni* has been found only in the spiracles of the grey skate; *Ch. ramosus* was found by Kröyer on the gills of the Thornback skate, *Raia clavata*, Linn.,* whereas the form I am now recording was found attached to the gill-arches (chiefly) and on the gills of *Raia circularis*.

Different specimens of *Ch. dubius* differ somewhat in the proportional lengths of the parts. The following tabular statement shows the lengths of two fairly typical specimens, to which the sizes of *Ch. dalmanni* are added for comparison:—

Length of	*Charopinus dubius.*		*Charopinus dalmanni.*
	No. 1.	No. 2.	
Second maxillipedes,	11 mm.	11·5 mm.	22 mm.
Anterior portion of thorax and head,	6 ,,	5 ,,	9 ,,
Posterior portion of thorax,	8·5 ,,	6 ,,	15 ,,
Posterior appendages,	4 ,,	4 ,,	10 ,,
Ovisacs,	18 ,,	damaged	20 ,,
Apex of second maxillipedes to end of ovisacs,	37 ,,	...	55 ,,
Apex of second maxillipedes to posterior end of thorax,	19 ,,	18 mm.	...

Genus *Lernæopoda*, Kröyer (1837).

Specimens of *Lernæopoda* have been obtained on a number of different kinds of fishes, and several species appear to be represented among them, but some of the so-called species approximate so closely as to render their identification somewhat difficult. Five species are recorded here.

Lernæopoda (?) elongata (Grant). (Pl. VIII., figs. 11–15.)

1827. *Lernæa elongata*, Grant, Brewster's Edin. Journ. Sci., vol. VII,, p. 147, Pl. II., fig. 5.

1850. *Lernæopoda elongata*, Baird, Brit. Entom., p. 333, Pl. XXXV., fig. 5.

The specimen I record under this name is rather smaller than those occasionally described, but it apparently agrees with the species named in some at least of its more important characters, *i.e.*, the form of the cephalic shield, the large and well-developed anterior pair of maxillipedes, and the very long and slender posterior maxillipedes. The abdomen is very short, and the posterior processes of the genital segment are almost obsolete.

The entire length of the specimen represented by the figure was at least three-quarters of an inch, and it was obtained on a porbeagle shark, *Lamna cornubica*. Where the fish was captured I cannot exactly say, though probably it was in the North Sea, somewhere off the Scottish coasts.

*Op. cit., p. 358.

One or two of the cephalo thoracic appendages are represented by figures 4–8.

Lernæopoda galei, Kröyer. (l. VIII., figs. 16–25.)

1837. *Lernæopoda galei*, Kr., Naturh. Tidsskr., R. i., vol. i., p. 272, Pl. III., fig. 5.

1850. *Lernæopoda galei*, Baird, op. cit., p. 334, Pl. XXXV., fig. 7.

A number of specimens of *Lernæopoda galei* have been obtained on tope (or topers, as the fish is sometimes called), *Galeus canis*, Rondel. (*Galeus vulgaris*, Flem.), occasionally brought to the Fish Market at Aberdeen. Specimens have also been sent to me by Mr. Duthie, the fishery officer at Girvan, which he had obtained on topers captured in Clyde waters and landed there. The parasites were most frequently found adhering to the skin beneath and between the ventral fins of male fishes; it appeared to be less frequent on females. *Lernæopoda galei* has also been obtained on a male specimen of the lesser spotted dog-fish, *Scyllium canicula*, caught in the Firth of Clyde, and on a specimen of the same kind of dog-fish sent from the Moray Firth. This Moray Firth specimen was also a male.

In this species of *Lernæopoda* the arms are only moderately elongated; the body becomes gradually dilated posteriorly, and is truncate at the end. The abdomen is almost obsolete, and is situated between two distinct though short and slender processes which spring from the end of the genital segment.

The antennules, antennæ, and mouth-organs are somewhat similar to those of *Lernæopoda elongata*. The specimen represented by the drawing is about 13mm. in length from the forehead to the end of the posterior appendages, and exclusive of the ovisacs and the second maxillipedes. In another specimen, which measured about 14mm., the ovisacs measured fully 9mm., and the posterior appendages about 3mm.

Lernæopoda bidiscalis, W. F. de Vismes Kane.

1892. *Lernæopoda bidiscalis*, W. F. de V. Kane, Proc. Roy. Irish Acad. (3), vol. ii., p. 203, Pls. IX. and X.

The species described under this name has hitherto been observed only on the male of the tope, *Galeus canis*. It is found adhering to the ends of the claspers, and the place where the parasites are attached is almost invariably found to be torn and bleeding. The describer of the species draws attention to this circumstance. I have found it to be almost invariably the case with topers landed at the Fish Market at Aberdeen, and Mr. Duthie, fishery officer at Girvan, finds that male topers caught in the Clyde and landed at that place have also the ends of the claspers torn and bleeding where these parasites were adhering. Whether these wounds are caused directly by the parasites or are produced by the efforts made by the sharks to shake off their tormentors is a question that does not yet appear to have received a satisfactory answer. Usually one, but sometimes two, parasites are found adhering to the same clasper, and on a few occasions we have found two parasites on each of the two claspers of the same fish. The fishes from which the parasites were obtained were chiefly adult males with well-developed claspers; we have rarely observed this *Lernæopod* adhering to the claspers of young males.

The specimens of *Lernæopoda bidiscalis* observed by us had for the

most part the anterior portion of the head of a bright red or orange colour, and frequently the male was found adhering to the female.

Tope (or topers) are occasionally brought to the Aberdeen Fish Market by the steam trawlers, and it is from the fishes landed there that I have obtained most of my specimens of this parasite. Mr. Duthie has recently, however, sent me specimens of the parasite obtained on male topers captured in the seaward portion of the Clyde and landed at that port. The discovery of this species by Mr. Duthie makes an interesting addition to the Clyde Copepod-fauna.

One of the more obvious characters by which the species may be distinguished is that of the comparatively large roundish disks which terminate the short second pair of maxillipedes. The whole animal is short and robust—very different in appearance from the more elegant *Lernæopoda galei.*

One of the most typical female specimens obtained by us gave the following measurements:—From forehead to end of thorax, 5·5mm.; from forehead to end of posterior thoracic appendages, 7mm.; from forehead to end of ovisacs, 13mm.; greatest width of thorax, almost 4mm.

The male of *Lernæopoda biliscalis* has a general resemblance to that of *Lernæopoda galei*, but the maxillipedes and other mouth-organs, and the antennal appendages, differ somewhat in structure from those of that species.

Lernæopoda salmonea (Gisler), (Pl. VIII., fig. 26.)

1751. *Pediculus salmonis*, Gisler, K. S. Vet. Ak. Handl., vol. xii, p. 171, Pl. VIII., figs. 1–5.
1761. *Lernæopoda salmonea*, Linn., Faun. Suec. (2nd edition), p. 509, No. 2102.
1850. *Lernæopoda salmonea*, Baird, op. cit., p. 335, Pl. XXXV., fig. 6.

This species was obtained on the gills of a diseased salmon, *Salmo salar*, caught in the Firth of Tay in January 1891, and also on the gills of a trout sent to the Fishery Board's laboratory from a loch in Sutherlandshire. *Lernæopoda salmonea* is a smaller species than any of the others already mentioned; the specimen represented by the figure measured only about 6mm.

In this species the arms are short and moderately stout. The cephalothorax seen from above is sub-triangular, while the posterior portion of the thorax assumes a sub-clavate form by gradually increasing in width towards the distal extremity. The posterior thoracic processes and the abdomen are very minute (fig. 26).

Lernæopoda cluthæ, sp. n. (Pl. VIII., figs. 27–37.).

The cephalothorax in this species is small and sub-triangular. A distinct and comparatively narrow neck connects the cephalothorax with the posterior portion of the body; this posterior portion is somewhat dilated and sub-cylindrical, and, in spirit specimens, shows a few pseudo-constrictions. Two short processes spring from the posterior end of the genital segment, and the abdomen, which is situated between these processes, is very small. The thoracic arms (second maxillipedes) are slender and of moderate length.

The antennules and antennæ are somewhat similar to those of species already recorded (figs. 30, 31). The mandibles are small, and their biting margins are finely and somewhat irregularly serrated, and in this respect they differ very markedly from the same appendages in *Lernæo-*

poda galei. The maxillæ (fig. 32) are small, and have the end-joint armed with two moderately elongate and stout terminal spines. The anterior foot-jaws (first maxillipedes, fig. 33) are more slender and rather more elongate than those of *Lernæopoda galei* (fig. 34).

The male of *Lernæopoda cluthæ* differs considerably from that of *Lernæopoda galei*, or *Lernæopoda biliscalis*, and especially so in the structure of the abdomen and caudal appendages. In the male of *Lernæopoda cluthæ* the abdomen is distinctly segmented, and the caudal furca consists of two slender processes, while in the two other species named the furca assumes the form of broadly oval, or club-shaped, appendages, divergent and reflexed upon the abdomen (fig. 37).

The female specimen represented by fig. 28 measures, from the front of the head to the end of the posterior thoracic appendages, 5mm., and from the termination of the same thoracic appendages to the extremity of the elongated second maxillipedes about 8mm. The posterior thoracic appendages are scarcely 1mm. long, and the length of the ovisacs, which varies considerably in different specimens, is scarcely 4mm., in the one represented by the figure.

Habitat.—Attached to the gill-filaments of the Fuller's Ray, *Raia fullonica*, captured in the Firth of Clyde in April 1897.

This *Lernæopod* is quite distinct from any of the other species recorded here. The form of the female; the form and armature of its mandibles, maxillæ, and first maxillipedes, and the general structure of the male, all differ from any other species of *Lernæopod* known to me.

Besides the species of *Lernæopoda* recorded in the preceding notes, there are other two forms which for the present will have to stand over, as there has not been time to study their characters sufficiently to allow of their being included in the present paper. One of these forms was obtained on the gill-filaments of the grey slate, *Raia batis*; the other was obtained on the gill-filaments of the cuckoo ray, *Raia circularis*, both from the Firth of Clyde.

Genus *Brachiella*, Cuvier.

This genus differs from *Lernæopoda* in having the cephalo-thorax more or less elongated and moderately slender. The arms (second maxillipedes), are, as in *Lernæopoda*, usually separate except at the ends where they are united to a hard horny button, which serves to anchor the parasite to its host. In some of the species at least there are two pairs of caudal appendages.

The following are the species of *Brachiella* that have come under my observation:—

Brachiella rostrata, Kröyer. (Pl. VIII., figs. 38–39.)

1837. *Brachiella rostrata*, Kr., Naturh. Tidsskr., R. i., vol. i., p. 207, Pl. II., fig. 1.
1864. *Brachiella rostrata*, Kr., op. cit., R. iii., vol. 2, p. 364, Pl. XVII., fig. 8.

A number of specimens of this fine species have been obtained on the gills of large halibut, *Hippoglossus vulgaris*, brought to the Fish Market at Aberdeen. In the female of *Brachiella rostrata*, the mouth-organs have a close resemblance to those of *Lernæopoda*. The mandibles and maxillæ of this species are somewhat similar to those of *Brachiella insidiosa*. The antennæ, which are moderately stout, do not show much structural development, and the anterior maxillipedes though short have moderately strong terminal claws.

The female specimen represented by the drawing (fig. 38) is fully 17mm. in length from the head to the end of the posterior thoracic appendages. The male of this species, one of which is represented by fig. 39, measures about 2mm. in length.

Brachiella insidiosa, Heller. (Pl. VIII., figs. 40 and 41.)

1865. *Brachiella insidiosa*, Heller, Reise der Novara, p. 239, Pl. XXIV., fig. 1.
1896. *Brachiella insidiosa*, Basset-Smith, Ann. and Mag. Nat. Hist. (6), vol. xviii., p. 14, Pl. VI., fig. 2.

This is a moderately robust species, the cephalothorax is short, and so are the second maxillipedes. There are two pairs of posterior appendages to the thorax in this species; those at the posterior angles are elongated and slender, and the intermediate ones are short (fig. 40). The female specimen represented by fig. 40 measured about 12·5mm.; the male (fig. 41) is somewhat like the male of *Brachiella rostrata*.

The mandibles in the female of *Brachiella insidiosa* are more powerfully armed than those of *B. rostrata*; but the maxillæ are rather smaller.

Habitat.—On the gills of hake, *Merluccius vulgaris*, captured in the Firths of Forth and Clyde, and on hake brought to the Fish Market at Aberdeen.

Brachiella merluccii, Basset-Smith. (Pl. VIII., fig. 42.)

1896. *Brachiella merluccii*, Basset-Smith, op. cit. (6), vol. xviii., p. 14, Pl. VI., fig. 1.

From Dr. Basset-Smith's description of this species, which contains all that is of special note concerning it, I extract the following reference to the general appearance of the female:—"Cephalothorax of moderate length, about equal to that of the genital segment, tapering towards the head and bent forward in an obtuse angle. Head slightly widest in front, the arms (second maxillipedes) not quite so long as the cephalothorax, being united in the whole length by a thin membrane. Organ of attachment, a chitinous cup with a short pedicle."

"Genital segment fiddle-shaped, very thick, carrying posteriorly two pairs of elongated processes; a dorsal pair directed backwards and outwards and a vertical pair rising on either side of a filiform abdomen (post-abdomen, Gerst.), these being directed backwards, outwards, and upwards, encircling the ovisacs."

In a concluding note Dr. Basset-Smith directs attention to the peculiar position which this species occupies in the genus *Brachiella*. According to the present classification this species, he says, should be placed with *Anchorella*, for in the female the second maxillipedes are short and are also united in their whole length, but the peculiar *Brachiella*-form of the male causes it to be placed in this genus.

From the peculiar habit of the animal it is somewhat difficult to get a specimen into a good position for drawing. Figure 42 gives a side view of a specimen measuring about 8·5mm. in length. The antennal appendages and mouth-organs agree in general structure with other species of *Brachiella*.

A certain amount of variation is observable between different specimens, but the general configuration of the animal, its short arms, and the number and position of the posterior appendages, are all so characteristic of the species that there need be little difficulty in identifying it.

I have obtained specimens of this *Brachiella* on hake captured in the

Firth of Clyde by the "Garland," and also on large hake brought to the Fish Market at Aberdeen. *Brachiella merluccii* is usually found attached to the gill-rakers of the hake, and chiefly on the larger specimens of the fish.

Genus *Anchorella*, Cuvier (1817).

In this genus the arm-shaped appendages are very short, and they are united to each other from the base so as to resemble a single organ (Baird).

Anchorella emarginata, Kröyer. (Pl. VIII., figs. 49–51.)

1837. *Anchorella emarginata*, Kr., Naturh. Tidsskr., R. i., vol. i., p. 287, Pl. III., fig. 7.

A specimen of *Anchorella* which appears to belong to *Anchorella emarginata*, Kr., was obtained on the gills of a twaite shad (*Clupea finta*) captured near Dunbar, at the mouth of the Firth of Forth, in February 1897. This form, though small, readily attracted one's attention because of its extremely long and slender cephalothorax when compared with the robust form of the body and ovisacs (fig. 49).

The antennules in this species are of moderate length and apparently three-jointed. The mandibles are very small and armed with a few teeth (fig. 51). The maxillæ are rather larger than the mandibles, and are provided with three apical spines; the secondary branches of the maxillæ are very small (fig. 50). The first maxillipedes are small and moderately strong; the terminal claws are small. Dr. Basset-Smith states that in this species the second maxillipedes are not completely united at their bases; this is shown to be the case in our specimen also. In this particular, *Anchorella emarginata* does not altogether agree with the characters of the genus, and seems to form a connecting link between that genus and *Brachiella*. On the other hand, *Brachiella merluccii*, as has been shown, partakes also of the characters of the same two genera, though apparently more closely allied to the genus to which it has been ascribed. It will be observed, further, that in this specimen now under consideration the cephalothorax springs apparently from near the middle of the genital segment and becomes somewhat attenuated towards the end; also that the abdomen is so minute that it is not shown in my drawing (fig. 49). This drawing represents a side view of the specimen, and the projection of the posterio-lateral lobe on the side next the observer prevents the abdomen from being seen.

The specimen, of which the figure is a representation, measures, exclusive of the elongated cephalothorax and of the ovisacs, scarcely two and a half millimeters in length.

Anchorella (?) *rugosa*, Kröyer. (Pl. VIII., figs. 45–48.)

1837. *Anchorella rugosa*, Kr., Naturh. Tidsskr., R. i., vol. i., p. 294, Pl. III., fig. 6.

1850. *Anchorella rugosa*, Baird, op. cit., p. 338, Pl. XXXV., fig. 8.

The *Anchorella* which I ascribe to Kröyer's *A. rugosa* was obtained on the gills and gill-covers of the cat-fish, *Anarrhichas lupus*, Linn., where it is sometimes not very rare. I find also on the cod-fish what appears to be the same species of *Anchorella*. It is evident, however, that these organisms, so far as the British species are concerned, require a more careful study than they have yet received.

Anchorella rugosa differs very distinctly from the last, especially by the structure of the second maxillipedes. In this species these appendages are much more atrophied, being reduced to little more than a small button-like projection at the anterior end of the robust genital segment. The cephalothorax is not so elongated as in the form just described; it is also proportionally stouter and more rugose. The genital segment is considerably dilated, and, when looked at from above, or below, has a nearly square outline, the two sides being slightly emarginate or constricted. The ovisacs are stout and of moderate length.

The antennules and mandibles (fig. 47) are somewhat similar to those of *Anchorella emarginata* but larger. The maxillæ are distinctly larger, besides being somewhat different in structure; moreover, the anterior maxillipedes are considerably stouter than the same organs of that species.

The male is greatly dilated on the dorsal aspect (fig. 46), and measures only about a millimetre in length. The anterior and posterior foot-jaws are stout, and armed with short but strong terminal claws.

I have obtained *Anchorella rugosa* on *Anarrhichas lupus* in the Firth of Forth and the Firth of Clyde, and also on the same species of fish brought to the Aberdeen Fish Market.

It seems to me that *Anchorella rugosa*, Kr., is quite distinct from *Anchorella emarginata*, Kr., as shown by that author's descriptions of the two forms. As these descriptions are short, it may be of interest to give them in the author's own words, which are as follow :—

Abdomine nullo vel indistincto.
Anchorella emarginata, Kr.

"Caput mediocre vel parvum, a collo bene distinctum ; collum gracile, longissimum; brachia gracilia, brevissima, bulla simplice; annulus genitalis dilatatus (latior fere quam longior), obcordatus, postice medio sinum præbens rotundatum."

Anchorella rugosa, Kr.

"Caput latum complanatum, a collo bene distinctum ; collum elongatum sed crassus, valde rugosum ; brachia fere rudimentaria, quasi in discum dilatata, bulla minuta, simplice ; annulus genitalis latior quam longior, sub-quadratus, postice late truncatus, supra infraque rugis sulcisque insignitus."

Dr. Baird's description of *Anchorella rugosa*, Kr., agrees with that of Kröyer, but the figure of the species seems to represent some other form. Kröyer in his remarks on the genus also refers to this difference in Dr. Baird's figure.* This want of agreement is probably due to some misunderstanding on the part of the artist.

Anchorella rugosa, var. (Pl. VIII., fig. 52.)

The specimen represented by figure 52, though it agrees very closely with that from the *Anarrchichas*, differs somewhat in the structure and armature of the mandibles and maxillæ ; the antennules also are slightly different, and will require further study. This form has been obtained on the haddock (*Gadus æglefinus*).

Anchorella uncinata, Müller. (Pl. VIII., figs. 43 and 44.)

1776. *Lernæa uncinata*, Muller, Zool. Dan., vol. i., Pl. XXXIII., fig. 2.
1850. *Anchorella uncinata*, Baird, op. cit., p. 337, Pl. XXXV., fig. 9.

Specimens of what I take to be this species are not uncommon on

* Naturh. Tidsskr., R. III., B. ii., p. 366 (1864).

species of *Gadus*, such, for example, as *Gadus merlangus*, captured in the Clyde and other parts of the Scottish coasts.

In this species (which belongs to Kröyer's division B) the abdomen is quite distinct, and is in the form of a prominent roundish knob. The cephalothorax, though nearly of the same length, is scarcely so stout as in *Anchorella rugosa*, but the second maxillipedes are more produced (fig. 43). The genital segment is moderately elongate and ovate. The female represented by the drawing measures about seven millimetres in length, exclusive of the cephalothorax and ovisacs.

The male, which is very small, has a general resemblance to the male of *Anchorella rugosa* (fig. 44).

The female antennules are moderately stout, and apparently three-jointed. The maxillæ are small, somewhat dilated towards the distal end, and provided with two terminal spines. The first maxillipedes are also small, they are each armed with a short terminal claw.

Anchorella stellata, Kröyer.

1838–39. *Anchorella stellata*, Kr., Naturh. Tidsskrift, R. i., vol. ii., p. 142, Pl. III., fig. 5.

1864. *Anchorella stellata*, Kr., op. cit., R. iii., vol. ii., p. 383.

This species of *Anchorella* was obtained on some specimens of hake, *Merluccius vulgaris*, forwarded from the Clyde to the Laboratory at Bay of Nigg. The fishes were captured by the "Garland" in Kilbrennan Sound on December 18th, 1899.

In *Anchorella stellata* the cephalothorax is moderately long and slender, and has the appearance of being continuous with, and but a prolongation of, the united second maxillipedes—the head being at one end of the prolongation and the chitinous plug, which terminates the maxillipedes, at the other; the length of this portion of the animal measures on an average about 6mm. The genital segment is ovoid in shape and measures about 4mm. in length by fully 2mm. in thickness. When the animal is alive or only recently dead this segment has the appearance of a pellucid and almost transparent bag, so that the creature is liable to be passed over under the belief that it is only a small roundish mass of mucus; in spirit the genital segment assumes a whitish appearance.

The membranous tissue surrounding the second pair of maxillipedes, and binding them together, is nearly transparent, and the maxillipedes could be easily seen side by side within their investment; it could also be observed that each maxilliped terminated in two or three minute roundish lobes, which together were arranged in a semi-circular manner round the inferior aspect of the apices of the maxillipedes, while from between the apices on the upper side proceeded the small chitinous process by which the creature attached itself to the fish. Moreover, in each of the specimens of this *Anchorella* that was examined, the chitinous process was observed to be adherent to the basal part of a scale, but the process did not penetrate through the scale, but spread out into a sucker-like disk between its outer and inner surfaces; and this sucker-like disk when closely examined exhibited a series of clear oval markings, which were arranged at regular intervals, and in a stellate manner, just within the circumference of the disk. The markings, which could be easily seen with a hand-lens, did not extend to the margin as shown in Kröyer's figure, but a small portion of the margin formed a continuous rim round the periphery of the disk; it is from this stellar arrangement of the pellucid markings that the specific name is derived.

The abdomen is scarcely developed in this species; it appears as a very

slightly produced middle portion of the posterior end of the genital segment, while on each side of it is a minute tubercle representing the posterio-lateral processes so characteristic of species of *Chondracanthus* and *Brachiella*.

The specimens of *Anchorella stellata* which I have observed were found adhering to the scales near the bases of the pectoral and ventral fins, especially those of the pectorals, of the hake. It is interesting to note that Krŏyer found his specimens of this *Anchorella* also on the same species of fish.

In concluding for the present these notes on the copepod parasites of fishes, I may mention one point which has been of some interest to me in the course of my study of the structural details of the various species I have had the privilege to examine. A cursory glance over the plates of figures which accompany these notes shows that almost all the species that have been recorded arrange themselves naturally into three distinct groups by the structure of their mandibles. In the group to which *Caligus* and *Lepeophtheirus* belong the mandibles are for the most part long and slender; their apex has usually a slight inward curve, and the inner edge of this curved portion is minutely serrated; the mandibles in this group are also usually composed of several more or less distinct joints.

In the second group represented by *Chondracanthus* the mandibles are large and falciform—somewhat like a broad-bladed scimitar—with one edge, and sometimes with both edges, fringed with setæ or teeth.

In the third group represented by *Brachiella* and *Lernæpoda* the mandibles assume a cleaver-like form, and the anterior third part, more or less, of the inner margin is nearly straight and armed with teeth usually coarse, and sometimes irregular in shape. Other peculiarities of structure —as for example, that of the antennules, characteristic of certain groups— may also be observed by anyone who cares to devote a little time to the study of these interesting organisms.

I will now proceed to notice briefly a few crustacean parasites of fishes belonging to some of the groups that have come under my observation, and my notes will, as in the preceding part of this paper, refer principally to Scottish species.

(1) Branchiura.

Argulus foliaceus, Linn.

A few years ago this curious little entomostracan was found to be very common on the greyling, *Thymallus vulgaris*, in the upper waters of the Clyde. So much were these fishes infested by the little parasites that they were blamed for being the cause of the unhealthy appearance which these fishes at this time had assumed. A friend secured a number of the parasites and sent them to me, and promised to try and obtain some more. It happened, however, that within the next few days a heavy rain set in and flooded the river, and he was thus prevented from securing other specimens; and when the weather moderated he found that the *Argulus* had all disappeared, and that the fish had assumed a more healthy appearance.

Argulus foliaceus has also been taken on the three-spined stickleback, *Gasterosteus aculeatus*, in the Union Canal near Edinburgh, by Miss Janet Carphin, who kindly presented me with a few specimens.

Several species of *Argulus* have been described by Continental writers on parasitic crustacea, but *A. foliaceus* is the only one I know of as occurring in Scottish waters.

(2) Isopoda Parasita.

Several species of the parasitic Isopods of fishes have been observed, of which the following may be referred to:—

Gnathia maxillaris (Mont.).

Specimens of *Gnathia*, which I consider to belong to this species, have been found adhering to the gills of the common gurnard, *Trigla gurnardus*, and of the lemon sole, *Pleuronectes microcephalus*, sent by the "Garland" from the Clyde to the Laboratory at Bay of Nigg. Females only of the *Gnathia* were observed, and in each case the Isopod was attached to the gills, under the gill-covers.

Æga strömii, Lütken.

A specimen of this Isopod was presented to me by one of the men on board a beam-trawl fishing boat belonging to Granton. The crustacean was found adhering to a large cod captured in the North Sea a considerable distance south-eastward of May Island.

Æga tridens, Leach.

A specimen of this species was brought to me by a Rothesay fisherman, who obtained it on a cod he had captured on his fishing lines in Rothesay Bay. One was obtained on a torsk in Aberdeen Fish Market on 15th September 1899.

Æga monophthalma (Johnston).

A fine specimen from a large cod captured by one of the Shetland fishing boats was handed to me for examination; it undoubtedly belonged to the species named, as described and figured in Prof. G. O. Sars' Crustacea of Norway, vol. ii.

I have had an opportunity of examining another fine species of *Æga*, viz., *Æga psora*. The species is included in the British fauna, but the specimens I saw were obtained on cod captured in Icelandic waters.

Cirolana borealis, Lilljeborg.

This Isopod is not very rare in the deeper parts of the Clyde, as, for example, to the east of Arran, in Kilbrennan Sound, and Loch Fyne, but I have never happened to find it there as a parasite. It has, however, been found adhering to several of the fishes brought to the Fish Market at Aberdeen, and on one or two occasions it was observed to be moderately frequent. I have notes of its occurrence on the following fishes:—The grey skate, *Raia batis*; the saithe, *Gadus virens*; the torsk, *Brosmius brosme*; and the conger, *Conger vulgaris*. The *Cirolana* were observed on the saithe in June, and on the conger in October, and on the other two species of fishes during the intervening months.

(3) Amphipoda Parasita.

There are only two Amphipods to which I wish to refer, viz.:—

Callisoma crenata, Spence Bate.

So far as I have been able to study the habits of this Amphipod, it seems to be a species whose energies are devoted for the most part to the removal of dead and decaying animal matter, rather than the destruction of living tissue. It would seem, however, that it does not confine its

operations to decaying animal matter, but is ready to attack living organisms should there be a favourable opportunity for doing so. In October last, when examining some specimens of *Galeus canis* in the Fish Market at Aberdeen, which had just been landed from one of the trawlers, a large male was observed to be infested with small amphipods. These amphipods belonged to the species named above—*Callisoma crenata*. It was found, on the closer examination of the fish, that the amphipods had penetrated the skin at the base of and immediately behind the claspers, and were burrowing in crowds in the hole they had formed. The skin and flesh of the fish appeared to be much injured by the parasites. Specimens of the same kind of fish were on one or two subsequent occasions observed to be similarly infested with the *Callisoma*.

Laphistius sturionis, Kröyer.

This Amphipod has been observed adhering to the cod, and also to the back of the angler, *Lophius piscatorius*, but only on the surface of the skin, and not, like *Callisoma*, burrowing in the flesh of the fish. *Laphistius* has been obtained as a parasite in the Firth of Forth and in the Firth of Clyde.

The following list contains the names of fishes on which the crustaceans, recorded in the preceding notes, were found :—

List of Fishes on which Copepod-Parasites have been Found.

Scientific names.	Common names.
Trigla lineata, Gmelin.	The Streaked Gurnard.
Trigla cuculus, Linn.	The Red Gurnard.
Trigla lucerna, Linn.	The Sapphirine Gurnard.
Trigla gurnardus, Linn.	The Grey Gurnard.
Agonus cataphractus, Linn.	The Pogge.
Zeus faber, Linn.	The John Dory.
Lophius piscatorius, Linn.	The Angler.
Gobius minutus, Gmelin.	The Spotted Goby.
Callionymus maculatus (Bonap.).	The Spotted Dragonet.
Cyclopterus lumpus, Linn.	The Lump-Sucker or Cockpaidle.
Anarrhichas lupus, Linn.	The Cat, or Wolf-fish.
Gasterosteus aculeatus, Linn.	The Three-spined Stickleback.
Gasterosteus spinachia, Linn.	The Fifteen-spined Stickleback.
Gadus callarius, Linn.	The Cod.
Gadus æglefinus, Linn.	The Haddock.
Gadus minutus, Linn.	The Poor or Power-cod.
Gadus merlangus, Linn.	The Whiting.
Gadus virens, Linn.	The Cod-fish or Saithe.
Gadus pollachius, Linn.	The Pollack or Lythe.
Merluccius vulgaris, Cuv.	The Hake.
Molua molva, Linn.	The Ling.
Onos (*Motella*) *cimbrius*, Linn.	The Four-bearded Rockling.
Brosmius brosme, Cuv.	The Torsk or Tusk.
Hippoglossus vulgaris (Flem.).	The Halibut.
Drepanopsetta platessoides.	The Long-Rough Dab.
Bothus (*Rhombus*) *maximus*, Linn.	The Turbot.
Bothus rhombus, Linn.	The Brill.
Pleuronectes platessa, Linn.	The Plaice.
Pleuronectes microcephalus, Don.	The Lemon Dab. Lemon Sole.
Pleuronectes cynoglossus, Linn.	The Pole Dab. Witch Sole.
Pleuronectes limanda, Linn.	The Common Dab.

List of Fishes on which Parasites have been Found—*continued.*

Scientific names.	Common names.
Pleuronectes flesus, Linn.	The Flounder.
Solea vulgaris, Quen.	The Sole. Black Sole.
Salmo salar, Linn.	The Salmon.
Salmo trutta (Flem.).	The Sea-trout.
Clupea sprattus, Linn.	The Sprat.
Clupea finta, Linn.	The Twaite Shad.
Conger vulgaris, Cuv.	The Conger.
Orthagoriscus mola, Linn.	The Short Sun-fish.
Galeus canis, Linn.	The Tope, or Toper.
Lamna cornubica, Cuv.	The Porbeagle Shark.
Scyllium canicula, Linn.	The Lesser-spotted Dog-fish.
Raia batis, Linn.	The Skate. Grey or Blue Skate.
Raia clavata, Linn.	The Thorny. Thornback Skate.
Raia oxyrhynchus, Linn.	The Long-nosed Skate.
Raia fullonica, Linn.	The Shagreen Ray, Fuller's Ray.
Raia circularis, Couch.	The Cuckoo Ray, Sandy Ray.

The number of fishes in this list is forty-seven. The majority of them have yielded one or two kinds of parasites only, while on a few as many as four and five different species have been obtained. The grey skate has yielded the largest number of parasites of any of the fishes examined, six different kinds having been found on specimens of this species. They comprise *Caligus curtus*, *Trebius caudatus*, *Chondracanthus annulatus*, *Charopinus dalmannii*, *Lernæopoda* sp, and *Cirolana borealis*. The saithe and the torsk come next with five species each. The hake and the toper have yielded four, while three each have been obtained on the common gurnard, the halibut, the turbot, the plaice, the conger, and the sun-fish. Eleven fishes have yielded two, and twenty-six only one species of parasite each.

Concluding Remarks.

The study of the distribution of these organisms is still being continued, and their habits and development will also form subjects of research as opportunities occur. It is probable that there is scarcely a fish within the Scottish seas, as there doubtless is in other seas, which does not at one time or other during its life harbour one or more crustacean parasites, and this itself furnishes a sufficient reason for the study of these creatures, and in this study more than one interesting problem is still awaiting solution. For example, we find, on the one hand, a species such as *Caligus curtus*, which seems to have no limit to the number of fishes from which to choose an associate for itself; on the other hand, we see a crustacean, such as *Lernæopoda bidiscalis*, which appears to be limited not only to a particular kind of fish, but also to a particular part of that fish. The interest in the difference between these two forms is increased when it is remembered that both in their early stages of life are free-swimming, and that they live in a medium which is favourable to their dispersal over a wide area; moreover, there are fishes of various kinds passing from time to time within easy reach of both during their free-swimming stages. How comes it, then, that in the one case the limit of existence in the adult is so greatly circumscribed, whilst there is almost unlimited scope in the other?

There is, of course, a possible explanation which might to a certain extent account for the difference I have alluded to, and that is that the difference is the product of the *habitat*; in other words, that the animals

were practically the same species, and that the differences observed in their form and structure were simply the result of the difference in the mode of life they had happened to adopt. One might, in support of such an explanation, point to the close resemblance to each other of the young of the so-called different species—a resemblance so close that at this early stage it is difficult even for an expert to decide in some cases which belongs to one species and which to the other.

It must also be admitted that in the adult forms of certain species modifications are observed which have a provoking tendency to bridge over the space that intervenes between one species and another, and which are exceedingly troublesome to the systematist.

Notwithstanding all this, however, the explanation I have referred to can scarcely be considered tenable, except to a very small extent. There are too many difficulties in the way of accepting such an explanation; but it shows that even in a limited subject like that of the parasites of fishes there is still work for the theorist as well as for the student who simply deals with the practical aspect of the study.

DESCRIPTION OF THE PLATES.

PLATE V.

Thersites yasterostei, Pagen.

Fig. 1. Female, dorsal view . . . . . × 40.
Fig. 2. Antennule . . . . . × 380.
Fig. 3. Antenna . . . . . × 253.
Fig. 4. Posterior foot-jaw . . . . . × 333.
Fig. 5. Foot of first pair . . . . . × 253.
Fig. 6. ,, fourth ,, ... × 253.
Fig. 7. Abdomen, dorsal view . . . . . × 127.

Caligus curtus, Müll.

Fig. 8. Female, dorsal view . . . . . × 48.
Fig. 9. Antenna . . . . . × 53.
Fig. 10. Sternal fork . . . . . × 53.
Fig. 11. Second foot-jaw . . . . . × 40.
Fig. 12. Foot of fourth pair . . . . . × 18.

Caligus rapax, M.-Edw.

Fig. 13. Female, dorsal view. . . . . × 7.
Fig. 14. Male ,, ... × 7.
Fig. 15. Mandible . . . . . × 166.
Fig. 16. One of the *palpi*—male . . . . . × 96.
Fig. 17. Sternal fork . . . . . × 80.
Fig. 18. Posterior foot-jaw . . . . . × 40.
Fig. 19. Foot of fourth pair . . . . . × 40.

Caligus diaphanus, Nordm.

Fig. 20. Female, dorsal view . . . . . × 11·4.
Fig. 21. Male ,, ... × 19.
Fig. 22. Mandible . . . . . × 253.
Fig. 23. Sternal fork . . . . . × 160.
Fig. 24. Posterior foot-jaw . . . . . × 80.
Fig. 25. Foot of fourth pair . . . . . × 60.

Lepeophtheirus pectoralis, Müll.

Fig. 26. Female, dorsal view, ... × 7·5.
Fig. 27. Male ,, ... × 16.
Fig. 28. Mandible . . . . . × 253.
Fig. 29. Sternal fork . . . . . × 80.
Fig. 30. Posterior foot-jaw . . . . . × 53.
Fig. 31. Foot of fourth pair . . . . . × 80.

Lepeophtheirus nordmanni (M.-Edw).

Fig. 32. Female, dorsal view . . . . . × 33.
Fig. 33. Antenna . . . . . × 20.
Fig. 34. Mandible . . . . . × 20.
Fig. 35. Sternal fork . . . . . × 20.
Fig. 36. Posterior foot-jaw . . . . . × 20.
Fig. 37. Foot of fourth pair . . . . . × 20.

Lepeophtheirus hippoglossi (Kr.).

Fig. 38. Female, dorsal view . . . . . × 3·7.
Fig. 39. Male ,, ... × 5.
Fig. 40. Mandible . . . . . × 88.
Fig. 41. Foot of fourth pair . . . . . × 9.
Fig. 42. Foot of fifth pair . . . . . × 190.

Lepeophtheirus thompsoni, Baird.

Fig. 43. Female, dorsal view . . . . . × 6·5.
Fig. 44. Sternal fork . . . . . × 80.
Fig. 45. Antenna . . . . . × 53.

PLATE VI.

Lepeophtheirus hippoglossi (Kr.).

Fig. 1. Posterior foot-jaw . . . . . × 26.
Fig. 2. Sternal fork . . . . . × 40.

Lepeophtheirus stromi, Baird.

Fig. 3. Female, dorsal view . . . . . × 4.
Fig. 4. One of the *palpi* . . . . . × 80.
Fig. 5. Sternal fork . . . . . × 53.
Fig. 6. Foot of fourth pair . . . . . × 26.
Fig. 7. Foot of fifth pair . . . . . × 190.
Fig. 8. Newly-hatched specimen . . . . . × 53.

Lepeophtheirus pollachii, Basset-Smith.

Fig. 9. Female, dorsal view . . . . . × 10.
Fig. 10. Male, dorsal view . . . . . × 13.
Fig. 11. Antenna . . . . . × 80.
Fig. 12. Mandible . . . . . × 165.
Fig. 13. Sternal fork . . . . . × 53.
Fig. 14. Second foot-jaw, female . . . . . × 26.
Fig. 15. Foot of fourth pair . . . . . × 26.

Lepeophtheirus (?) *obscurus*, Baird.

Fig. 16. Female, dorsal view . . . . . × 10.
Fig. 17. Antenna . . . . . × 80.
Fig. 18. Sternal fork . . . . . Enlarged.
Fig. 19. Foot of fourth pair . . . . . × 53.

Trebius caudatus, Kr.

Fig. 20. Female, dorsal view . . . . . × 6·6.
Fig. 21. Male ,, ... × 11.
Fig. 22. Antenna . . . . . × 40.
Fig. 23. Sternal fork . . . . . × 80.
Fig. 24. Mandible . . . . . × 103.
Fig. 25. Posterior foot-jaw . . . . . × 40.
Fig. 26. Foot of fourth pair . . . . . × 26.

Dinematura producta (Müll.).

Fig. 27. Female, dorsal view . . . . . × 3·3.
Fig. 28. Antenna . . . . . × 13.
Fig. 29. Mandible . . . . . × 53.
Fig. 30. Anterior foot-jaw . . . . . × 13.
Fig. 31. Caudal furca . . . . . × 5.

Echthrogaleus coleoptratus, Guérin.

Fig. 32. Female, dorsal view . . . . . × 6.

Pandarus bicolor, Leach.

Fig. 33. Female, dorsal view . . . . . × 8.
Fig. 34. Male (?) ,, ... × 7·5.
Fig. 35. Antenna, female . . . . . × 35.
Fig. 36. ,, male . . . . . × 35.
Fig. 37. Foot of second pair, female . . . . . × 18.
Fig. 38. ,, ,, male . . . . . × 26.

Lemargus muricatus, Kr.

Fig. 39. Female, dorsal view . . . . . × 3·3.
Fig. 40. Mandible . . . . . × 53.
Fig. 41. Anterior foot-jaw . . . . . × 13.
Fig. 42. Posterior foot-jaw . . . . . × 12.

PLATE VII.

Clavella hippoglossi, Kr.

Fig. 1. Female, dorsal view . . . . . × 10.
Fig. 2. Antennule . . . . . × 95.
Fig. 3. Antenna . . . . . × 40.
Fig. 4. Mandible . . . . . × 500.
Fig. 5. Posterior foot-jaw . . . . . × 84.
Fig. 6. Foot of first pair . . . . . × 126.

Lernæenicus sprattæ (Sow.).

Fig. 7. Parasite *in situ* on eye of sprat . . . . Natural size.
Fig. 8. Female, dorsal view . . . . . × 7¼.
Fig. 9. Antennule . . . . . × 126.
Fig. 10. Antenna . . . . . × 80.

Lernæa branchialis, Lin.

Fig. 11. Female, dorsal view . . . . . × 1¾.
Fig. 12. ,, var. . . . . × 1¾.

Lernæa minuta, n. sp.

Fig. 13. Female, dorsal view . . . . . × 7.

Hæmobaphes cyclopterina (Fabr.)

Fig. 14. Female, dorsal view . . . . . × 6.

Hermolaphes ambiguus, n. sp.

Fig. 15. Female, dorsal view . . . . . × 7.

Oralien asellinus (Linn.)

Fig. 16. Female, dorsal view . . . . . × 4·8.
Fig. 17. Antennule . . . . . × 152.
Fig. 18. Mandible . . . . . × 152.

Chondracanthus cornutus (Müll.).

Fig. 19. Female, dorsal view . . . . . × 4·8.
Fig. 20. Antennule . . . . . × 27.
Fig. 21. Antenna . . . . . × 40.
Fig. 22. Mandible . . . . . × 84.
Fig. 23. Anterior foot-jaw . . . . . × 126.
Fig. 24. Male, dorsal view . . . . . × 53.
Fig. 25. Foot of first pair . . . . . × 250.
Fig. 26. Foot of second pair . . . . . × 250.
Fig. 27. Female, dorsal view, var. . . . . × 4·8.
Fig. 28. Antennule . . . . . × 35.
Fig. 29. Mandible . . . . . × 123.
Fig. 30. Foot of second pair . . . . . × 760.
Fig. 31. Foot of first pair . . . . . × 760.

Chondracanthus fluræ, Kr.

Fig. 32. Female, dorsal view . . . . . × 6.
Fig. 33. Antennule . . . . . × 35.
Fig. 34. Mandible . . . . . × 84.

Chondracanthus clavatus, Basset-Smith.

Fig. 35. Female, dorsal view . . . . . × 6·4.
Fig. 36. Antennule . . . . . × 35.
Fig. 37. Mandible . . . . . × 84.

Chondracanthus limandæ, Kr.

Fig. 38. Female, dorsal view . . . . . × 12.
Fig. 39. Antennule . . . . . × 80.
Fig. 40. Mandible . . . . . × 250.

Chondracanthus soleæ, Kr.

Fig. 41. Female, dorsal view . . . . . × 6·4.
Fig. 42. Antennule . . . . . × 40.
Fig. 43. Mandible . . . . . × 126.
Fig. 44. Antennule, male . . . . . × 380.
Fig. 45. Foot of second pair . . . . . × 380.

Chondracanthus annulatus, Olsson.

Fig. 46. Female, dorsal view . . . . . × 4.
Fig. 47. Male ,, ... × 40.
Fig. 48. Antennule, female . . . . . × 84.
Fig. 49. Mandible ,, ... × 126.
Fig. 50. Antennule, male . . . . . × 380.
Fig. 51. Antenna ,, ... × 190.

PLATE VIII.

Chondracanthus zeus, De la Roche.

Fig. 1. Female, dorsal view . . . . . × 3·7.

Thysanote impudica (Nordm.).

Fig. 2. Female, dorsal view . . . . . × 9·6.
Fig. 3. Mandible . . . . . × 250.
Fig. 4. Maxilla . . . . . × 250.
Fig. 5. Anterior foot-jaw . . . . . × 80.

Charopinus dalmanni (Retz.).

Fig. 6. Female, dorsal view . . . . . × 1·3.
Fig. 7. Male, side view . . . . . × 14.
Fig. 8. Antenna . . . . . × 168.
Fig. 9. Mandible . . . . . × 127.
Fig. 10. Maxilla . . . . . × 127.

Lernæopoda elongata (Grant).

Fig. 11. Female, dorsal view . . . . . × 4·7.
Fig. 12. Antenna . . . . . × 53.
Fig. 13. Mandible . . . . . × 80.
Fig. 14. Maxilla . . . . . × 80.
Fig. 15. Anterior foot-jaw . . . . . × 40.

Lernæopoda galei, Kr.

Fig. 16. Female, side view . . . . . × 4.
Fig. 17. Male, side view . . . . . × 16.
Fig. 18. Antennule, female . . . . . × 126.
Fig. 19. Antenna, ,, ... × 20.
Fig. 20. Mandible . . . . . × 126.
Fig. 21. Maxilla . . . . . × 126.
Fig. 22. Anterior foot-jaw, female . . . . × 53.
Fig. 23. Anterior foot-jaw, male . . . . . × 64.
Fig. 24. Posterior foot-jaw, ,, ... × 64.
Fig. 25. Abdomen, ,, ... × 26.

Lernæopoda salmonea (Gisler.).

Fig. 26. Female, dorsal view . . . . . × 6.

Lernæopoda cluthæ, n. sp.

Fig. 27. Female, side view . . . . . × 10.
Fig. 28. ,, dorsal view . . . . . × 7·5.
Fig. 29. Male, side view . . . . . × 42.
Fig. 30. Antennule, female . . . . . × 195.
Fig. 31. Antenna . . . . . × 195.
Fig. 32. Mandible . . . . . × 380.
Fig. 33. Maxilla . . . . . × 380.
Fig. 34. Anterior foot-jaw . . . . . × 80.
Fig. 35. Anterior foot-jaw, male . . . . . × 95.
Fig. 36. Posterior foot-jaw ,, ... × 95.
Fig. 37. Abdomen ,, ... × 53.

Brachiella rostrata, Kr.

Fig. 38. Female, dorsal view . . . . . × 4·7.
Fig. 39. Male, side view . . . . . × 18.

Brachiella insidiosa, Heller.

Fig. 40. Female, dorsal view . . . . . × 3·5.
Fig. 41. Male, side view . . . . . × 9·6.

Brachiella merluccii, Bassett-Smith.

Fig. 42. Female, side view . . . . . × 5·3.

Anchorella uncinata (Müll.).

Fig. 43. Female, side view . . . . . × 3·8.
Fig. 44. Male, side view . . . . . × 64.

Anchorella rugosa, Kr.

Fig. 45. Female, side view . . . . . × 3·8.
Fig. 46. Male, side view. . . . . × 32.
Fig. 47. Mandible . . . . . × 380.
Fig. 48. Maxilla . . . . . × 190.

Anchorella emarginata, Kr.

Fig. 49. Female, side view . . . . . × 11·4.
Fig. 50. Maxilla . . . . . × 380.
Fig. 51. Mandible. . . . . × 380.

Anchorella (?) rugosa, var.

Fig. 52. Female, side view . . . . . × 3·8.

IV.—CONTRIBUTIONS TOWARDS THE NATURAL HISTORY OF THE PLAICE *(P. PLATESSA L.)*.

By H. M. Kyle, M.A., B.Sc., Exhibition Science Scholar, St. Andrews. (Plates IX.–X.)

CONTENTS.

	Page.
Introduction,	189
Average-Size at First-Maturity,	190
Variability and the Method of Treating Variations,	201
The Various Forms of Variability.	207
I. Sex-Variability,	207
II. Growth-Variability,	212
III. Race-Variability,	220
Conclusion	237

INTRODUCTION.

The following pages contain the record of a portion of the work that has been going on for some time, and was concerned with the variations and variability of the plaice. It was at first proposed to collect and examine material from various places over the whole area inhabited by the plaice before publishing anything, but the work threatened to grow beyond all control, and it was thought advisable, for this as well as for other reasons of expediency, to work through a small portion thoroughly, so that the experience thereby gained might be of service to myself and others in the further development of the work.

The leading ideas contained in the present paper may be briefly stated. In the science of the fisheries the great bugbear to the naturalist, placing almost insuperable difficulties in the way of framing definite conclusions with regard to anything whatsoever, has been the great range of variations which everything—structure, size, rate of growth, spawning season, &c.—displays. This difficulty has not been confined, as is well known, to fisheries, but is common to every department of biology. The presence of this variability accounts for much of the indefiniteness and inconclusiveness of the work of the past. Within recent years, however, the prolonged endeavours of Galton and the stimulus given to the subject by the brilliant work of Bateson and Pearson, have been successful in establishing a method of treating variations and in founding thereby a new school of thought. In fisheries, Heincke has been the first to introduce the new method, and with it further original developments more particularly suited to the work on fishes. The present paper displays the working of this method so far as the material was suited to it. The various forms of variability and the problems in connection therewith are discussed. Race-variability is shown to be distinct from sex and growth variability; their close relationship, however, is made evident, and the various and diverse causes of race-variations are displayed. Incidentally to the main body of the work, the material was found suitable to the discussion of a hitherto unsolved problem, and a method is shown by which this problem, the average size at which the plaice becomes ripe for the first time, may be solved.

With the exception of the herring, there is no species concerning which so much has been written as the plaice. A summary of this past literature has not been thought suited to the present instalment of the work,

and reference has only been made to the literature directly bearing upon the subject.

The number of persons to whom I have been indebted during the progress of this work is large. To Dr. Hoek, the talented director of the Netherlands Zoological Station at Helder, and his assistant, Dr. Redeke, I am indebted for a very pleasant sojourn at Helder, as well as for many suggestive criticisms of my work. Dr. M'Intosh, my own Professor at St. Andrews University, has never failed me with his kindly advice and assistance. Dr. Fulton, the Scientific Superintendent of the Scottish Fishery Board, kindly granted me the use of the Marine Station at Nigg for a short period, and gave me a portion of my material. But, above all, am I indebted to the generous and friendly circle of Heligoland. Not only had I the pleasure of good company and the use of their Biological Station, including a considerable amount of material, but I had also the benefit of advice and counsel from Professor Heincke and Dr. Ehrenbaum over the initial, and perhaps the roughest, stages of the work. May beginners always find such friendly and capable advisers.

I have also to acknowledge the generous gift of £20 from the Worshipful Company of Fishmongers, London, which has aided me greatly in defraying the costs of material and transport.

Average Size at First-Maturity.

The combination of words, "first-maturity," does not seem very happy, but it is difficult to find any other short and compact expression which would explain the meaning intended. A fish is said to be mature once and for all when its reproductive organs have become ripe. There are some difficulties in the way of accepting this definition as perfectly general—*e.g.*, the young of the salmon—but such is the usage of the term, and this is the meaning employed here. "First-maturity" is then taken to mean, the first time that the reproductive organs become ripe.

A few years ago, when questions concerning the supposed decrease of fish in the sea were more in evidence than they are perhaps at present, attention was drawn to the great destruction of young immature fish that was going on. It was believed by many that this was one of the chief causes of the decrease, and it was therefore thought that if certain size-limits were fixed to prevent the fish below these limits from being brought to the market, then the young fish would have a better chance of becoming mature, and thence of maintaining the species.

The present investigations were not directly undertaken with the view of deciding what this size-limit should be, and it was only when the materials had been collected that they were seen to possess an importance previously unsuspected concerning this very question. The number of specimens is not so large as those of several naturalists who have previously investigated this subject, but large enough to illustrate a method of grouping the mature and immature fish which displays better than has previously been done the average-size at which the plaice spawn for the first time.

Before entering upon the discussion proper, it is advisable to distinguish between certain definite points—(1) The size-limit below which no plaice are allowed to be sold. This size-limit differs in the various countries where such limits exist, and has been fixed by the respective Governments solely from practical expediency, and not from any consideration of its biological aspect. (2) The size at which the plaice are on the average in the best condition for the market—*i.e.*, the best value-size. This size was first suggested and defined by Petersen* of Den-

* Petersen, C. G. J. *Report of the Danish Biol. Station*, IV., 1893.

mark, and from the economic point of view it is obviously of the greatest importance. (3) The lowest size at which the plaice is mature. This was laid stress on by Fulton* as being the most serviceable limit, from the practical point of view, for legislative purposes. (4) The average size of all the mature plaice. This was also defined by Fulton (*l.c.*), and is of interest, because it shows by contrast with the size at which the plaice become ripe for the first time that the great majority of mature plaice elude capture during their first spawning season, and survive to spawn several times. (5) The greatest size at which the plaice is immature—*i.e.*, the size at which all or nearly all have spawned. This was first proposed by Holt† in the course of his North Sea investigations, and was founded on the supposition that such a size-limit was necessary, because the numbers of plaice in the North Sea were on the decrease. (6) The average size at which the plaice become ripe for the first time—*i.e.*, the size at which as many plaice are immature as mature, below which more are immature than mature, and above which more are mature than immature. This size-limit has been spoken of by previous observers, but no endeavours have ever been made to fix it definitely.

From the biological point of view, the last is perhaps the most interesting and most important of the above size-limits. It is the size-limit that seems the most difficult to fix, and yet is in reality one of the easiest. It is the most representative size when two groups of the same species or two species have to be compared. The other size-limits refer to only a portion of the range of variations in the sizes of mature plaice, whereas the average-size when first-mature is the centre point of the range. And again, if regulations are to be framed upon such limits discovered by naturalists, then the average-size at which the plaice spawn for the first time is the most serviceable, from the biological point of view.

Referring now to the earlier work on this subject, and taking up, firstly, that done on the east coast of England, it is necessary to give a brief description of the observations and conclusions of Holt (*l.c.*). These observations, as already mentioned, were carried on with the object of obtaining the upper size-limit above which all or nearly all fish had spawned. Hence, a process of selection was carried on of the mature and immature, which unfortunately renders his tables of little use for the present purpose. Thus, the males were almost entirely disregarded, because it was well known previously that they spawned at a much smaller size than the females. Again, the females were also selected, those which were mature below a certain length the upper size-limit, being specially sought for, and likewise the immature above this limit, which was found to be 17 inches (43cm.). The smallest female that he found mature was 13 inches (33cm.), and very few mature specimens, comparatively speaking, were found between this size and 17 inches. On the other hand, ripe males were common as low as 9 inches (23cm.), and an exceptional one was ripe at 6 inches (15cm.).

In comparison with the numbers and sizes to be presently given, these show a greater range of variation, but as Holt included the whole North Sea—or rather the North Sea north from Grimsby—this greater range is easily accounted for. The plaice of the northerly North Sea are mature for the first time at a greater size than those from the English coast and southerly portions of the North Sea, and this difference would cause a greater range of variation. Otherwise there does not seem any pronounced difference between the sizes given by Holt and those found by myself.

* Fulton, T. W. *Eighth Rep., Fish. Board for Scotland*, 1890.

† Holt, E. W. L. *Jour. Mar. Biol. Ass.*, Vol. II., 1892.

This size-limit of 17 inches is, therefore, the upper limit, or nearly so, at which immature plaice—*i.e.*, those which have never spawned—are found in the North Sea. At 18 inches Holt considered that the proportion of immature to mature was "infinitesimal." One specimen with ovaries unripe was obtained at a greater size than 18 inches, but later in the season, and it was probably a "spent," not immature, fish.

The distinction between *spent* or *spawned* fish and *immature* fish may be referred to briefly before proceeding further. The *immature* fish are those which have never spawned and show no signs of going to spawn. If they show signs of going to spawn in the ensuing season, they may be taken as *ripe* for the purposes of this paper. The *spent* or *spawned* fish are those which have spawned at some time or other. Theoretically, the distinction is great, but in practice it is at times exceedingly difficult to discriminate between the two. According to Holt, the spent fish could always be distinguished from the immature, either by the presence of some remaining ripe ova, by the shrunken condition of the ovary, or when the ovary had contracted to its previous condition of unripeness by the groove that remains along the interspinous rays where the developed ovary had been. The two former characteristics always lead to a certain diagnosis of the spent condition, but the last has been called in question by Cunningham, and I have also found it unreliable. The groove or hollow along the interspinous rays is present (to a certain extent) in the young forms, which are evidently immature, and is, therefore, not diagnostic of the spawned condition. In short, so far as I have been able to determine up to the present, the ovary and the parts in connection with the ovary return to exactly the same condition in the spawned fish as they were previously in the immature.* It should be mentioned that Cunningham imagined at one time that he had discovered a sure sign of the spawned fish in small opaque bodies which he found intermixed with the undeveloped ova. These he thought were the degenerated remains of ova which had matured to a certain extent, but had not been spawned with the rest, and had then atrophied. He withdrew this distinction later, however, when he found that these opaque bodies were present in ovaries of small fish which were really immature. When the spawned fish is given time to return to its condition previous to spawning, there are, therefore, so far as known, no means of distinguishing the spent from the immature fish.

During the spawning season—from December to May for the whole North Sea—the difficulty of distinguishing between the spent and immature conditions is not great except at the very beginning and the end of the season. Doubtful cases certainly occurred in the course of my own investigations between these times in the case of large fish with unripe reproductive organs; but their number was comparatively small, and I have thought it better to consider them immature. At the beginning of the season and earlier—during October, November, and the first half of December—the difficulty was to tell whether a fish with reproductive organs a little larger than the normal unripe condition was really going to spawn that season or not. In consequence of this difficulty I have been obliged to form a third class, and consider a number of fish as "doubtfuls." These will be referred to later. At present it may be said that the difficulty of distinguishing between a spent and immature fish, and of telling whether a fish is going to spawn in the ensuing season or not, is greater for the males than for the females.

Cunningham† was the next naturalist who took up this matter in England. He found that for the plaice of the English Channel 15in.

* Petersen and Fulton (*l.c.*) were of the same opinion.

† *Jour. Mar. Biol. Ass.*, Vol. III., 1893, p. 70.

(381mm.) was the size at which all or nearly all were mature. This size was contrasted with that given by Holt (17in.), and was considered as indicating a racial difference in the plaice of the North Sea and of the English Channel. The borderland between the altogether immature and the altogether mature was found to be from 9–12in. (229–305mm.) for the males and from 9–14½in. (229–368mm.) for the females. The averages for these borderlands were considered to be about 10in. (254mm.) for the males and 12–13in. (305–330mm.) for the females.

At a later date the same naturalist continued the work of Holt on the east coast of England, but while Holt had studied for the most part the forms from the North Sea north of Grimsby, Cunningham investigated those from the southerly portions of the North Sea mostly, and more especially those from around Lowestoft. There is consequently a considerable difference in their results, the sizes given by the latter being much smaller than those given by Holt. Fortunately, the data recorded by Cunningham are sufficiently numerous and representative to be restated according to the method here proposed.

The following Table represents the totals of five different lots of plaice* collected from the same region—the southerly portion of the North Sea, and about the same time—from October to December. The specimens obtained by Cunningham from Geestemunde are omitted, as they came from another part of the North Sea, and do not seem representative.

TABLE I.

Proportions of Mature to Immature Plaice at Different Sizes.

Sex.	Condition of Reproductive Organs.	Size in Inches.									
		8	9	10	11	12	13	14	15	16	17
Males . .	Immature . .	1	10	27	20	12	11	2	1	—	—
	Mature . .	—	6	17	30	26	10	2	5	14	—
Do. *in percentage*	Immature . .	100	63	61	40	32	52	50	17	—	—
	Mature . .	—	37	39	60	68	48	50	83	100	—
Females . .	Immature . .	—	8	46	74	67	30	18	6	3	1
	Mature . .	—	1	2	18	24	21	7	9	13	9
Do. *in percentage*	Immature . .	—	89	96	80	74	59	72	40	19	10
	Mature . .	—	11	4	20	26	41	28	60	81	90

The proportions of immature and mature at each size are arranged in percentages, because by so doing the inequalities in the numbers of specimens at the different sizes are done away with. A comparison can then be drawn between the number of mature specimens at the different sizes, and similarly for the immature. In calculating the percentages the nearest whole numbers are always taken.

* "North Sea Investigations:" *Jour. Mar. Biol. Ass.*, Vol. IV., 1895, p. 106 *et seq.*

The advantage of this method lies in the clear and simple manner by which it shows the proportions of the mature to immature at the different sizes. Theoretically, if there is a true average at first maturity in nature —above which more are mature than immature, below which more immature than mature—this can only be where 50 per cent. of the one coincide with 50 per cent. of the other. Hence, if these percentages be plotted out as two curves, the point where the curve of immaturity crosses that of maturity is the point required at which the plaice are ripe on the average for the first time. In practice, however, this point is difficult to obtain. In theory, trustworthy curves and averages could only be obtained if a very large number of specimens at each size was examined, and it is further necessary that these should not be specially selected. Again, the specimens should be taken from the same region and at the same time—viz., the spawning season. If these conditions are not fulfilled then certain irregularities may appear in the curves, and it will be difficult to frame any conclusion. Such irregularities, however, do not destroy the efficacy of these curves; on the contrary, by means of the curves not only are the irregularities shown, but their causes and thence their explanation as well.

In the data given by Cunningham, for example, the percentages of the immature start from 100 and descend to almost nothing, whilst those of the mature start from 0 and mount up to 100. (*Vide* Plate IX.). This is the general trend of the curves, but it will be remarked that both for the males and females a fluctuation occurs so that the course of the curves is not quite uniform. This is partly due to the smaller number of specimens that have been examined at certain sizes than at others. Where the specimens are fairly numerous, as between 10–12in. for the males and 10–13in. for the females, the trend of both curves in each case is uniform. After these sizes the numbers decrease and irregularities appear. In such cases it is evident that the general trend of the curves has to be taken into consideration, otherwise no conclusions could be drawn. A further discussion of Cunningham's data and the curves that result therefrom will be entered into later, when the comparison is made between them and my own. It may be said at present, however, that, so far as numbers are concerned, Cunningham's data are better than mine, but the relative numbers at the different sizes are not so well proportioned.

In the following Tables the specimens from Heligoland, Helder, Lowestoft, and Grimsby are included together. The relatively small numbers from each place necessitated this; but the fact that the characters so far examined for the purpose of detecting races are almost identical in all four groups, as well as that the spawning season seems to be the same in all, makes this course a reasonable one. The inclusion of these four groups, on the other hand, will give a common average for the plaice of the southerly portion of the North Sea—south of the Dogger Bank—and this is an advantage if any common size-limit is wanted for legislative purposes.

These specimens are therefore considered as coming from one and the same biological region—*i.e.*, one in which the surrounding conditions are for the time being thought to be the same. On the other hand, the specimens from Aberdeen are separated from these because the characters differ, as will be shown later.

Something further may be said concerning the method. The range of variation within which the specimens fall lies between 240mm. and 380mm. (9·5 to 15in.), and it is divided into seven portions of 20mm. each. The specimens whose lengths fall within each division are considered to be half-way between the limits—*i.e.*, at 250, 270, and so on. By this method a more exact result is obtained than when the different lots are taken to the nearest inch. When the percentages of immature

and mature in each division have been calculated, it will be noticed that whilst the proportions between the different divisions are made more equable, yet those within each division are magnified, because in each case a multiplier has to be used to bring each lot to a percentage. Hence, if there is any great disproportion between the numbers of the different divisions this disproportion will be displayed by the multiplier used. For example, if there are 50 in one division and only 5 in another, these two divisions will be brought to the same level in the percentages, and yet the value of the latter group is only $\frac{1}{10}$ of the former. In the case of the specimens from the southerly portion of the North Sea this disproportion is not great because the multipliers are small; in the case of the Aberdeen specimens it is much larger. Theoretically, this error would be done away with if a hundred specimens in each division were examined, and under such ideal conditions the only errors that could enter into the calculation would be errors of observation.

Table II.

Showing the Relative Proportions of the Immature and Mature Plaice at Different Sizes, from the Southerly Portion of the North Sea.

1. Males.

Region.	Condition of Reproductive Organs.	Size in Millimetres.						
		240-260	260-280	280-300	300-320	320-340	340-360	360-380
Helder	Immature	4	6	6	3	0	0	0
	Mature	4	7	10	4	1	3	5
Lowestoft	Immature	0	3	6	5	0	1	0
	Mature	2	5	16	10	14	15	10
Grimsby	Immature	3	1	2	2	0	1	0
	Mature	0	2	0	5	9	13	10
Total	Immature	7	10	14	10	0	2	0
(188)	Mature	6	14	26	19	24	31	25
Do. *in per-centage*	Immature	54	42	35	35	0	6	0
	Mature	46	58	65	65	100	94	100

2. FEMALES.

Region.	Condition of Reproductive Organs.	Size in Millimetres.						
		240-260	260-280	280-300	300-320	320-340	340-360	360-380
Heligoland	Immature	16	7	2	6	10	2	0
	Mature	1	0	0	4	19	13	10
Helder	Immature	14	21	17	10	0	0	0
	Mature	1	0	3	4	1	3	2
Lowestoft	Immature	1	8	16	14	5	1	0
	Mature	0	0	2	3	4	4	2
Grimsby	Immature	1	1	4	5	5	3	1
	Mature	0	0	0	3	6	6	8
Total (269)	Immature	32	37	39	35	20	6	1
	Mature	2	0	5	14	30	26	22
Do. *in percentage*	Immature	94	100	89	71	40	19	4
	Mature	6	0	11	29	60	81	96

From the first Table, which gives the proportions of the immature and mature male specimens, those from Heligoland are omitted, because there were very few specimens, and some doubtfully mature amongst them. It will be seen from the percentage columns that the relative numbers in the different divisions are more evenly distributed than they were in the case of the data given by Cunningham, and the resulting curves are therefore more uniform.

A certain allowance should be made for growth, because the specimens were not all collected at the same time. Those from Heligoland were obtained mostly during October, those from Helder towards the end of November, and those from Lowestoft and Grimsby during the spawning season in January, February, and March. No correction is required for the last, but those from Helder are at least two months from the height of the spawning season, and those from Heligoland four months. The average rate of growth yearly has been calculated for the earlier periods by Cunningham,* Petersen,† Masterman,‡ and more recently by Dannevig,§ and although there are considerable differences in their results, yet it is allowable to conclude that for the stage in question the plaice grow from 2–3in. (50–76mm.) in a year. The correction to be made

* Cunningham, J. C. *Jour. Mar. Biol. Ass.*, Vol. II., 1891-92.

† Petersen, C. G. J. *Fourth Rep. of the Danish Biol. Station*, 1893.

‡ Masterman, A. T. *Thirteenth Rep., Scot. Fish. Board*, 1895.

§ Dannevig, H. *Seventeenth Rep., Scot. Fish. Board*, pp. 232-246.

for the specimens from Heligoland is, therefore, about 20mm., and for those from Helder 10mm. A slight advantage is given to the immature, as they probably grow faster than the mature at this period.

The values are plotted out in the curves shown on Plate IX.—the light lines representing the observed percentages, the dark lines the corrected numbers. The first two curves (A) have been sketched from the data in Table I. given by Cunningham, and in these the abscissal axis is marked out in inches. In the following curves this axis is marked in centimetres. In all cases the ordinate axis represents the percentage values as given in Tables I. and II. An inspection of the first set of curves—those formed from the data given by Cunningham—shows that both for the males and the females the courses of the curves are irregular. The points which mark the percentages do not lie on one straight continuous curve, but on one which rises and falls irregularly, and the irregularity is more marked in the case of the males. The reasons for this irregularity may lie in the insufficient number of specimens at certain sizes or in their non-representative nature. The irregularity is restricted, however, to certain definite points, and the general trend of the curves seems sufficiently evident to permit free-hand outlines of the probably correct courses of the curves over the points of irregularity. This outline is represented by the dotted lines.

It will be remarked that in all the pairs of curves, the curve of the mature specimens begins between 8 and 10in. (20·3 and 25·4cm.) at or near $^{0}/_{00}$, and mounts up gradually until between 14 and 17in. (35·0–43·2cm.) it approaches 100 $^{0}/_{00}$. The curve of the immature specimens, on the other hand, follows the reverse course, beginning about 100 $^{0}/_{00}$ and ending at 0 $^{0}/_{00}$. The two curves cross on the 50 $^{0}/_{00}$ line, and the point of crossing is taken to represent the average of the combined curves. The abscissa of this point is then considered to represent the average size at which plaice are ripe for the first time. In the case of the curves formed from the data given by Cunningham, this length is 13·7in. (34·8cm.) for the females and 10·5in. (26·6cm.) for the males. If a slight correction, similar to that already described, be made for growth, these averages become 14in. (35·6cm.) for the females and 10·8in. (27·4cm.) for the males. In the case of the curves formed from my own observations, the corrected averages are 33·2cm. (13·1in.) for the females and 26·6cm. (10·5in.) for the males.

It appears, therefore, that the average size at first-maturity for the plaice of the southerly North Sea lies between 13 and 14in. for the females and 10–11in. for the males. The close agreement between the two sets of observations is somewhat remarkable when the comparatively small number of specimens is considered, and shows that these averages must be close approximations to the real averages in nature. It has to be remarked also that the males are mature at a size 3 inches smaller on an average than the females. This difference may correspond to a year's growth—*i.e.*, the males may be mature a year earlier than the females.

If attention is again directed to the second set of curves (B), it will be noticed that the curves are open at both ends. This permits of the possibility that mature specimens may be found below the lowest limits recorded, and immature specimens above the highest limits. In accordance with this possibility, Cunningham has found mature female specimens at 9in. (22·9cm.) and mature males at 6in. (15·2cm.) There is, therefore, again a difference of 3in. between the earliest mature male and female, and this may correspond, as above stated, to a year's difference in age. The general slope of the curves for the female specimens probably represents better than any of the others what actually occurs.

A few "precocious" specimens become mature at a small size, from 9 to 11in. (22·9 to 27·7cm.); then the number of the mature increases rapidly, showing that the great majority become mature between 11 and 15in. (27·9 and 38·1cm.). This means that they become mature at the same average-age, which, if Dannevig's calculation be taken, is probably at five years old. According to Petersen's and Masterman's calculations, this average-age may be four years. The males become mature a year younger.

If the curves between 12 and 15in. (30–38cm.) be again considered, it will be noticed that they approximate, in the case of the females, very closely to two straight lines. This agrees with the notion that we have a single year's group between these sizes. The variation in the size of these mature specimens probably arises from the initial difference in age, to be referred to later in the section on "Variability," and this being so, the relative proportions of the mature and immature specimens should alter so rapidly and uniformly as to be represented best by two straight lines.

At the upper limits, on the other hand, we have to consider the presence of large immature specimens. From my own observations, the largest immature was 15in. (38cm.) for the females and 14in. (35·5 cm.) for the males; but the general trend of the curves admits the possibility of finding immature specimens at a larger size than this. And Cunningham's data shows that these may occur up to 17in. for the females and 15in. for the males. As with the earliest mature specimens, these are scattered examples, though probably of constant occurrence. If we suppose that they become mature in the following year, then we are perhaps justified in declariug that all the females are mature in their sixth year, and all males in their fifth at the latest. The exact upper limit in size is hard to fix, but may be taken as about 17in. for the females and 15in. for the males. The ranges of variation would, therefore, appear to be from 9 to 17in. for the females and 6 to 15in. for the males, and three years would be the range in time. Such seem to be the facts, although the reasons for these great ranges of variation are not yet evident.

We may turn now to the specimens from the northerly portion of the North Sea, which include those from Aberdeen and from St. Andrews. In Table III. they are arranged according to size, in the same manner as those of the southerly North Sea in Table II. The numbers of specimens are not so great as were those of the latter region, and more especially is this the case with the females. Consequently, when the numbers are divided into eight divisions, there are very few in certain of the divisions—from 320 to 420 mm.—and the value of the observed proportions of the immature and mature is therefore seriously affected. The multipliers that require to be employed in order to obtain the percentages lie between 3 and 8 in the case of the males, but between 3 and 20 for the females. No definite conclusions can be drawn in the latter case, and only the one set of curves, representing the male specimens, has been drawn. (Plate X.)

TABLE III.

Showing the Relative Proportions of the Immature and Mature Plaice at Different Sizes, from the Northerly Portion of the North Sea.

Sex.	Condition of Reproductive Organs.	Size in Millimetres.							
		260-280	280-300	300-320	320-340	340-360	360-380	380-400	400-420
Males	Immature	12	25	23	7	1	0	0	—
	Mature	2	5	15	22	12	19	6	—
Do. *in percentage*	Immature	86	83	61	24	8	0	0	—
	Mature	14	17	39	76	92	100	100	—
Females	Immature	0	21	24	7	1	0	2	0
	Mature	0	0	3	3	4	12	5	7
Do. *in percentage*	Immature	100	100	89	70	20	0	29	0
	Mature	0	0	11	30	80	100	71	100

From these curves it is seen that the point of crossing lies very close to 320cm. (about 12·5in.). The lower limit of the mature specimens begins lower than 26·0cm. (10in. approximately), whilst the upper limit of the immature is about 37cm. (14·5in.). The range of variation does not seem to be so great therefore for the northerly specimens as for the southerly, but this may arise from the smaller number of specimens examined. If the distance between the average sizes of the males and females at maturity which was observed in the specimens from the southerly North Sea—viz., 7·0cm. (about 3in.)—be utilised for those from the northerly North Sea, then the average size, when the female plaice of the latter region become ripe for the first time, is about 39·6cm. or 15·5in.

The average size at first-maturity for the male plaice of the southerly North Sea was found to be about 26·0cm., a difference of 6cm., or more than 2in., from that of the northerly North Sea. Whether this difference means that the plaice of the latter region become mature at a later age—*i.e.*, a year later, than those of the former it is impossible at present to say. It may be that they grow much faster and spawn at the same average age; but this question can only be satisfactorily determined when the ages at different sizes can be ascertained.

On the east coast of Scotland, Fulton* has investigated the sizes at which the plaice becomes mature, the relative proportions of males to females, and their average as well as maximum sizes. The average size at first-maturity was not specially sought for, and it is consequently impossible to compare his results and my own with any definiteness. The limit between immaturity and maturity—*i.e.*, the commencement of maturity—is placed about 12–13in. This agrees exactly with what has been recorded here for the females, but it has been shown that the males may be mature at 11in. and even lower.

A comparison may be drawn between the average sizes at maturity of the North Sea plaice and those of the Kattegat and Baltic. Petersen states

* Fulton, T. W.: *Eighth Rep., Scot. Fish. Board*, pp. 161, 162; *Tenth Rep., Scot. Fish. Board*, pp. 239 *et seq.*; *Twelfth Rep., Scot. Fish. Board*, p. 307.

that these average sizes are 10in. in the Baltic, 11in. in the Lesser Belt, and 12–13in. in the Kattegat. These refer to both males and females although the males are said to be somewhat smaller. These sizes (p. 3) are said to represent the average size of the mature fish, but there seems to be some discrepancy between the stated sizes, and what one may gather from the Tables. In the Kattegat, for example, Table I.* shows that immature specimens were obtained at 15 to 16in., and even as high as 19in. (These are in Danish inches—in English inches the sizes would be a little less than half an inch larger.) It seems strange, therefore, that the average-size of the mature specimens of the Kattegat should be so low as 12-13in. From the Tables, indeed, one would infer that the average size at maturity was even greater than 12–13in. The data, unfortunately, do not lend themselves to the present mode of treating the subject, and I am therefore compelled to leave the matter in an indefinite state. From the resemblance that the plaice of the Kattegat have to the North Sea plaice, and from their actual geographical continuity with them—*i.e.*, with those of the Danish coasts of the North Sea—it seems more probable that 12–13in. is about the average size when they become ripe for the first time. The average for the females is perhaps higher than this, that for the males lower.

In conclusion, a brief reference may be made to the usefulness of the average-size when plaice become mature. Quite apart from the legislative and practical aspects of obtaining by its means a reasonable size-limit for the protection of the young immature fish, there is another aspect of far greater importance.

The average sizes at maturity and first-maturity might be put to effective use in order to tell whether the fish on any area are really decreasing. So far as known there are two effects of over-fishing—the larger fish grow scarce, and the average size of the mature fish consequently decreases. Whether the average size at first-maturity also decreases is not yet definitely known, but it may not do so. The averages found from Cunningham's data differed very little from those of my own, although several years intervened. In the Kattegat, again, the fishing is so severe that large specimens have entirely disappeared, and it is even doubtful whether any plaice survive to spawn twice. Yet the average size at first-maturity, on this supposition, is not much less than that for the North Sea specimens. The average size at first-maturity probably depends upon the surrounding conditions and not upon any change in the total number of fish. If it does vary, however, decreasing with the decreasing number of fish, its variations may be calculated in different years.

The greatest and most certain sign of a decrease in the number of fish on an area, apart from direct statistics, is to be found in the decrease of the average size at maturity. This represents the average size to which the plaice attain after they are mature, and if this size be compared with the average size at first-maturity we should know what proportion of plaice elude capture and spawn several times. By investigating these two averages in different years we should be able to tell whether the mature fish are decreasing or not. For example, it has been shown here that the average size at first-maturity for the female plaice of the northerly North Sea is about 15·5 in., and Fulton has shown that the average size of the mature specimens of the same region was about 20 in. some years ago. If this latter average still holds good, it is evident that more than half of the mature plaice in this region must escape capture and spawn several times, in spite of the refined methods of fishing now practised.

The method of finding out whether the number of fish on an area is

* *Rep. Dan. Biol. Station*, 1893.

really decreasing or not is therefore simple. It is necessary to calculate the average-size at first-maturity and that of the total mature, care being taken that the specimens are not specially selected and are yet representative for the area in question. The changes in the averages, and the changes in the relative distance between them, will show the change in the number of mature specimens, and thence in the total number of fish on that area. The investigations should be repeated for several years in succession in order to avoid the possible yearly fluctuation, and again some years later.

Variability and the Method of Treating Variations.

This complex subject has been dealt with recently by so many different writers and in so many different ways that it is impossible to give a complete digest of all the views concerning the method and its usefulness within the reasonable compass demanded by this paper. The mathematical aspect of the study has now assumed a definite form, with regard to its more elementary portions at any rate, and the introduction of shorter modes of working by Pearson and Duncker has greatly reduced the old labour and drudgery. This aspect of the method is described by Davenport,* and more fully by Duncker.†

So far as the biological aspect of the method is concerned, the study of variations is passing through a transitional period. For this aspect one must turn to Galton,‡ Weldon,§ and Heincke.‖

In the following pages the endeavour will be made to maintain the biological aspect constantly in the foreground, and to display the mathematical method as merely an instrument and aid, though a powerful one. The higher developments of the method, the determination of curves, and the correlation of different structures, are not shown here because the material is not very well suited for them. Attention is therefore directed to the simpler and more elementary portions, which in the present condition of the study are by far the most important.

The necessary foundations for the study are of course the facts of variation and the characters that vary. Here, at the very beginning of the study, we find that its use with regard to fishery research has diverged widely from that in other departments. In the latter one or two characters only have been taken, such as the number of fin-rays, of glands, the height or breadth of various parts, and so on; their manner of varying has been displayed, and sometimes the correlation of one part with another. There are certain noteworthy exceptions, such as the works of Weldon on the Crustacea and of Bumpus on the Sparrow, and it is more than probable, now that the newness of the method has worn off, that more characters in each animal will be examined in future. Heincke has set the example for this in fishery research, and one can readily understand the reason. We do not wish to know how this or that character varies by itself; we wish to know how many vary in relation to one another; in short, how the organism varies. For this purpose a large number of characters has to be examined, and fewer specimens can be taken than was formerly the case.

In fishery research the method has been employed for the separation of groups of individuals from one another. Before entering upon the research it has been impossible hitherto to foretell how many individuals

*Davenport, C. B.: "Statistical Methods," 1899; Chapman & Hall, London.

†Duncker, G.: "Die Methode der Variationsstatistik, *Arch. für Entwick*, B. VIII., 1899.

‡Galton, F.: "Natural Inheritance," 1889; also *Proc. Roy. Soc.*, Vol. LXI., 1897.

§Weldon, W. F. R.: "Remarks on Variation in Animals and Plants, *Proc. Roy. Soc.*, Vol. LVII., 1895; also Presidential Address to the British Association, 1898.

‖Heincke, F.: "Naturgeschichte des Herings," *Abhandl. d. Deut. Seefisch*, V., 1898.

of each group would be required, and even now no definite rules can be given. Some characters are more valuable for the research than others, and fewer specimens are necessary for these than for other characters. It is necessary, further, to sub-divide each group according to size or sex, and if the differences between each group are small the number of specimens examined must be greatly increased. In the present work it has been found that two hundred specimens about the same size permit definite conclusions to be drawn. If the number in the sub-group falls below fifty the conclusions become uncertain.

The choice of characters is also a matter of moment. There is no doubt that numerical parts ("integral variates"), such as the vertebræ and fin-rays, are the easiest to manipulate and sometimes the most suitable, but this is not always the case. Even over a wide area, such as the North Sea, these characters may not show any appreciable change in their averages. This will be shown in the case of the plaice, and it probably occurs in many other forms. Differences do occur, however, in some forms, as in the herring and the plaice of the Baltic, and it is always advisable to choose these parts for study. Of more importance, however, are the "dimensional" and "substantive" variations. These arise from linear parts, length, breadth, form, &c., and from the mass or weight of structures. These have been disregarded hitherto by most workers on variation, chiefly on account of the difficulty of obtaining exact measurements. The reason is quite valid, and great care has to be exercised in the choice of the dimensions, and of the conditions under which the measurements are taken. If possible, fresh specimens should be examined, but if preserving agents are used then the contraction or expansion of each measured part has to be determined. This gives rise to a great amount of labour, and it is better to examine only fresh specimens. Soft or flexible parts should also be avoided, because the errors arising from faulty observation may be considerable. Matthews and Heincke have shown, however, that certain characters in the round fishes are valuable, although they involve the measurement of soft and flexible parts. Such characters are the relative distances of the fins from the snout and tail. The changes that take place in these during growth are well known in the cases of the sand-eel and young herring, and they are therefore of importance for investigation. It is preferable, however, to choose the dimensions on the skeleton—*e.g.*, the skull and vertebræ—of which the measurements can be made accurate to within half a millimetre.

In the present work the large majority of the measurements consisted of these dimensions on the skeleton. Exceptions were the height of the body and length of tail, and in these cases the error of observation would be within 1.5–2mm. only. It is on account of these possible errors that such dimensions are unsatisfactory. In a large number of specimens the errors will be distributed almost equally about the mean, and hence will not affect the average of the character, but they will affect the standard deviation, and hence the fluctuations of the averages. These will be presently defined; at present it is sufficient to say that the conclusions that might be drawn from the averages are thereby rendered uncertain.

The number of characters that should be chosen depends upon the object desired. If it is desired to ascertain whether groups or races exist, or to investigate the variations due to sex or age, it is advisable to examine a large number. This part of the study is still somewhat unsettled, but a few general considerations may be stated. The changes that arise during growth, or from differences in the environment, are, apart from the "integral variates," changes in the relative proportions of the structures of the body, and these are concerned with the movements of the animal, its balance or equilibrium. It is necessary, therefore, to choose such

parts as will best express this balance. The skull, for example, is in proportion to the caudal region, the height of the body is correlated with the height of the skull, the position of the fins is connected with the movements of the body, and so on. The various dimensions which express these relations should be chosen, and not one only of a structure but several. By choosing several dimensions of one structure the conclusions in the end are more certain and satisfactory, even though something is added to the labour.

The measurement of the mass or weight of the various parts and structures has not yet been attempted on account of the great practical difficulties in the way. When these have been overcome and accuracy in measurement attained a new and valuable field for the study of variations will be opened up. In connection with the taking of the measurements, further, it may be said that each species presents different possibilities. In addition to the general considerations, it is therefore necessary to take note of the characters which differentiate a species from its nearest allies. Systematists have hitherto chosen the superficial characters for the most part in order to distinguish between species, but it is becoming more and more apparent that if we are ever to gain a definite notion of the "species" and its mode of origin in any one case, we must penetrate to the internal morphological differences, and from these limit off the species from one another. The distances between various species (as between herring and sprat, plaice and flounder) may differ in the various genera; we do not yet know. And here again, as Heincke points out, the study of variations methodically carried on is part of the work of the present-day morphologist and systematist.

The methods by which the measurements are taken are various, and depend a great deal on the ingenuity of the observer. Davenport (*l.c.*) explains the various methods now in use, but there is still scope and need for more accurate ways of taking measurements. This is a separate study in itself demanding special attention, and in a short time it is probable that the laboratory of the biologist will be supplied with instruments as delicate and accurate as those of the physicist and chemist. For the present work the ordinary instruments only have been used, but it is hoped to make some improvements in the future stages of the study.

When the characters have been measured and their values tabulated it is necessary to reduce them to their percentage-values with respect to some common standard, otherwise they would not be directly comparable. The common standard chosen by different observers is not always the same. The total length of the fish, or this length minus the length of tail, are usually taken. In the present work, the total length minus tail-length and skull-length has been chosen as standard, and is called "body-length" throughout, although the small distance between the tip of the snout and the anterior end of the vomer is included therein. The choice of this standard is not merely a matter of convenience. It has to be chosen so that the differences in the values of the various dimensions are fairly represented in the averages. If the standard dimension is itself under or near 100 of the units employed (millimetres, say), this condition is always fulfilled. But if the standard is large, over 200 and more, then it will be necessary, in order to bring this down to 100, to divide it always by a larger number than 2. Each dimension must be so divided, consequently, and the differences between the original values will be reduced according to the value of the divisor. Thus, if the divisor is 3 or 10, then a difference of 3 or 10 in the observed values becomes only 1 in the percentages. This difficulty is certainly obviated if the standard is taken as 1000, and the secondary dimensions expressed in thousandths, but this increases the labour of calculation enormously. It is advisable, therefore,

to use percentages, and in order to do so, and avoid at the same time the above-mentioned difficulty, the standard dimension should be chosen as near 100 as possible.

Certain parts of the body, again, may be grouped together if they are related to one another. Thus, the height or breadth of the tail is usually expressed—when it is taken—in terms of the tail-length, and the breadth and height of the skull are expressed in percentages of the skull-length. For the present work forty characters in all have been taken, but only a few of these have been chosen for the present paper, as it was thought better to direct more attention to the thorough working out of the method in a few cases than to the superficial display of the variations of many characters. The characters chosen are probably the most valuable for the purposes required, but the value of the others has yet to be decided.

When the percentage-values of a character are arranged in order it is found that a varying number of individuals come under each percentage. Each percentage-value is called a "variate" or "variant," and the number of individuals under each variant is the "frequency" of the variant. The variant having the largest frequency is called the "mode." When the average or mean has been calculated these variants are commonly spoken of as "deviations." More strictly used, the term "deviation" applies to the distances that the variants are from the mean or average. When these distances have been calculated their average may be obtained, and this is called the "average deviation" of the variants. Within recent years, however, biologists, following the advice and example of Pearson, do not employ the average deviation, but the "error of mean square" of the deviations. This is obtained from the formula

$$\sigma = \sqrt{\frac{\Sigma (x^2 \cdot f)}{n}},$$

where x is any deviation, f its frequency, and n the total number of individuals. σ, the so-called "error of mean square" of the physicists, is called the "standard deviation" or "index of variability" by biologists. It is employed to represent the range of variations or the "variability" of a character, and is useful in comparing the variability of different organs n the same species or the same organ in different species.

A short method of obtaining σ, given by Pearson and described by Duncker, consists in taking the "mode" as the approximate average, calling it 0 and the deviations from it + 1, + 2, + 3, etc., on the one side, and—1—2—3, etc., on the other. Calculating the "average deviation" of these (having regard for the signs) we obtain the distance of the true average of the variants from the mode. The sum of the squares of these deviations is then calculated, according to the formula $\Sigma (n^2 f)$, and σ is then obtained from the formula—

$$\sigma = \frac{1}{n} \sqrt{n \Sigma (x^2 f) - [\Sigma (x f)]^2},$$

where x is any one of the integral deviations, and f its frequency as before. Since this mode of working involves only whole numbers, it is obviously much simpler than the older method of employing the actual deviations from the true average, which meant using numbers of two and three figures where now 0, 1, 2, etc., are used.

The further processes in the development of the mathematical method are borrowed from the mathematical theory of probabilities. Without entering into the reasoning of their mathematical aspect, which may be found in the writings of Galton, Weldon, and Heincke (*l.c.*), it is necessary to show their biological meaning. The individuals examined represent only a very small fraction of the total number of individuals in the group. Hence the average found for the observed individuals is only probably

the true average of the total number. The amount of probability can be calculated from the following formula. The probably true value of the standard deviation or

$$P.\sigma. = 0{\cdot}6745\ \sigma,$$

and dividing this by the square root of the number of individuals observed, or $\sqrt{n}$, we obtain the probable error (r) of the observed average. The true average for the total number of individuals in the group will then probably lie between $M \pm r$, where M is the observed average. According to Davenport, if we take three times r, then the probability is 19 to 1 that the true average will lie between $M \pm 3r$. If we take five times r, then, according to Heincke, the probability is 1000 to 1 that the true average lies between $M \pm 5r$.* Through this method, therefore, we are given the means of testing and telling the amount of probability or certainty in our results.

The further developments of the mathematical theory—the plotting-out and determination of the variations-curves, the correlation of variations and of averages—are not employed in the present paper, and may be left for future discussion.

A few words should be said as to the meaning of the words "variation" and "variability." According to the common usage in Biology, "variation" is a general and vague term, which might be applied to either "variants" or "deviations" as defined above. For common usage this does not much matter, and in the present paper the term is employed in its general sense. But a good deal of confusion would arise in the mathematical method if its meaning were not made more precise. In the more restricted sense now employed, "variations" mean the observed deviations expressed in terms of the standard deviation.

The definition of the term "variability" is extremely difficult. It is one of those words which imply potentiality or possibility, and is best described by showing what it is not. Any character whatsoever presents a series and range of variations, but variability is not the variations nor the range of variations. These are the outward expressions or indications of the variability, which is something potential and innate. In one and the same individual, again, the characters do not all remain constant and unchanging throughout life, but alter with growth, and here, again, variability is not the actually observed change, but the possibility of that or any other change. Variability is, however, not indefinite, so far as we know, but gives rise to variations which are limited within a certain range. Variability is thus a general term which indicates the power that an organism possesses of giving rise to variations. These variations are particular observed objects more correctly spoken of by reference to a particular observed average, and their standard deviation about that average is a measure of the variability, and is thence called the "index of variability."

The various forms of "variability" will be presently dealt with; meanwhile it is of importance to show more closely the underlying meaning and inter-relation of these conceptions. This subject has recently been discussed by Professor Sedgwick,† who endeavours to make a generic division of variations into two kinds—genetic and acquired. Genetic variations are inherent in the constitution of the individual. They arise in the germ in consequence of conjugation, and manifest themselves in "habit, constitution, form, and structure." They have nothing to do with the environmental conditions. On the other hand, acquired

* The "fluctuations of the averages" in the Tables are based upon the formula $M \pm 5r$.

† Address to the Zoological Section of the British Association, Dover, 1899.

characters or variations are "those which are caused by the direct action of external conditions." Theoretically, the difference seems obvious, yet, when it comes to the working out in details, Sedgwick's own words show that the distinction breaks down. In one place (p. 8) he says "it would appear, then, that every feature which successively appears in an organism in the march from the uninucleated zygote to death is an acquired character." If so, how should we be able to tell that any observed change in habit, constitution, form, or structure was genetic?

This point is of the utmost importance in many ways, and the crux of Sedgwick's position is found when we take the environment into consideration. If we could conceive of a zygote developing into an adult or passing through any stage whatsoever independent of the environment—*i.e.*, "outside of" an environment—then we should unhesitatingly call its features "genetic." But do any features arise independent of external stimuli? So long as we are forced to believe that an organism is in touch with the environment from beginning to end, then, according to his own definition, we are obliged to call every feature or variation "acquired." The difficulty arises from the new meaning which Sedgwick has given to the words "acquired characters." Formerly these meant simply such changes as were directly traceable to some impression of the environment, such as mutilations, and to such as were caused by the activity of the organism, such as the increase of muscular tissue. The old meaning was, however, too indefinite and vague, and Sedgwick's definition undoubtedly clears the air. If we accept his definition of "acquired character" as given above, it is evident that we now require a new classification of acquired characters.

On this view therefore we may call the observed particular features of any organ or structure an "acquired character," and the advantage of this is that our attention is directed to the environmental conditions—*i.e.*, the stimuli which have led to the appearance of this particular feature. Behind these characters is the formative protoplasm which tends to take definite shape in diverse ways—*i.e.*, possesses "variability"—and is finally led into one particular line by particular stimuli of the environment.

We may briefly refer also to the complex question of heredity. If all the particular features of structure and form of an organism are acquired in its own individual life-time, what does it receive by inheritance? Obviously, as Sedgwick points out, we may conclude from the above reasoning that the offspring does not receive through the germ any particular feature whatsoever—*i.e.*, acquired characters are not inherited. If the same features recur in successive generations we should look for the reason in the continuation or successive reappearance of similar environmental stimuli. The importance of this conclusion is widespread, for we account for the appearance and reappearance of particular features in parent and offspring, not merely by the continuity of the germplasms, but also by the continuity of the environmental conditions. In other words, the so-called inheritance that parents bestow upon their offspring is the inheritance of better, worse, or similar living conditions to those they themselves possessed.

It follows from these conceptions that when we talk of particular characters being "preserved by inheritance" we mean that the environmental conditions must remain the same. Thus, if we should find that a particular species of fish, say, the herring or the plaice, was divisible into groups, and we should say that the essential condition for the permanence of each group was the continual inheritance of the parental characteristics, we mean that the environmental conditions must remain similar or nearly so throughout. If we had reason to believe that these conditions altered, or that the parents, through migration or otherwise, did not

return continually to similar spawning places under similar conditions, we should be forced to admit the uselessness of searching for groups or "races." It will be shown, however, on the contrary, that we have good evidence to believe that through habit or instinct the animals of a group return constantly to approximately the same places and conditions where they were born in order to spawn. Thus, we have the essential "inherited" conditions for the maintenance of a group or race.

What would happen, however, if the conditions changed in the meanwhile? Obviously we could not expect the "acquired characters" to remain constant. If the change was so extreme that the variability possessed by the organism could not respond to the impressed stimuli we should expect that none of the offspring would survive. As an example of this wholesale destruction of a group or species may be mentioned the remarkable case of the tile-fish in American waters. If the variability possessed by the organism was, however, equal to the emergency, then we should expect that the new "acquired characters" would differ greatly from the old, and would be similar to the characters of any other group of the same species which had formerly lived under these new conditions. If the new conditions had come to stay, might we not believe that "through the nature of the organism and of surrounding conditions, but not through natural selection,"* a new group or race had been formed, and if a new group, why not a "new" species?

This conceivable mode of the differentiation or formation of species, is not to be confounded with "evolution" or the process by which one form has developed from another so that the distinction of higher and lower may be made—which is a related yet quite separate problem.

The Various Forms of Variability.

The questions in connection with variability resolve themselves into at least three distinct main problems, which are so closely related to one another that it is necessary to treat of them together, and yet so complex and large that they demand separate attention and study. These problems arise from the different ways that the variability of the organism shows itself. There are (1) *sex-variability*; (2) *growth-variability*; (3) *race- or family-variability*. Another form of variability has been suggested by Heincke, namely, *asexual variability*, which is meant to include the differences that would be found between two groups of animals after the other forms of variability have been eliminated. It is doubtful, however, whether these differences would not come under the heading (3) race-variability in the end.

I. *Sex-variability.*—Sex-differences are divided into two classes—primary, those directly concerned with the reproductive organs; secondly, those not so connected, but in some way related to sexuality. Only the latter group come into the present research. In the class of fishes, as a whole, secondary sexual differences are not so well marked as in other vertebrates, but where they do occur they manifest themselves in a similar way, in colouration, structure of the jaw, for example. The question is whether they occur in the plaice.

No very definite external differences have been found except in the case of "ciliated scales," and even this is doubtful. Both Duncker† and Cunningham‡ found that the mature males possessed these scales, but

* Darwin, C.: "Origin of Species," ed. 6, p. 176; cited by Professor Sedgwick, *l.c.*, p. 12.

† Duncker, G.: "Variation u. Verwandtschaft v. *P. flesus* L. u. *P. platessa* L.," *Wissen Meeresunter.*, B.T.H. 2, 1896.

‡ Cunningham, J. C.: "Peculiarities of Plaice from different Fishing Grounds," *Jour. Mar. Biol. Ass.*, Vol. IV., 1897, pp. 315–357.

Cunningham shows that they are to be also found, though much less frequently, in the females. It is given by Duncker and Cunningham, however, as a secondary sexual character, although it may be associated rather with some peculiarity in the environment, because it seems to occur more frequently in the Baltic plaice than in those of the North Sea.

Other secondary sexual differences found by Duncker and Cunningham lay in the height of the body, length of the head, and number of vertebræ and fin-rays. The conclusions of Duncker were, however, inconclusive,* because of the small number of specimens that he worked with, and because the majority were immature. The differences due to growth, therefore, are not clearly separated from those of sex. Cunningham's conclusions labour under the latter difficulty also, and they are even more unsatisfactory, because he did not calculate the averages.

The various characters examined by these observers may be gone over in detail.

Vertebræ and Fin-rays.—These have been examined for sexual differences without result. One example only need be taken. In the adjoining Table IV. the frequencies of the dorsal fin-rays in both sexes and in different regions are given in full, the averages of each are given in the fourth column, and the fluctuations of the total averages are stated at the foot.

A glance at the averages will show that they are on the whole slightly larger for the males than the females—a result in contradiction to Cunningham's conclusion, but that the fluctuations of the total averages overlap and agree more than they disagree. The conclusion is, therefore, forced upon us that we cannot find any secondary sexual differences in the dorsal fin-rays. In a short preliminary note of his work on the variability of the flounder, Duncker† shows the same result for all the fins.

The vertebræ and other fins examined by myself lead to the like conclusion, and in their work on the herring both Matthews‡ and Heincke§ found the same thing. It is allowable, therefore, to take the males and females together so far as regards the numbers of vertebræ and fin-rays.

* See criticism of Duncker's work by F. B. Stead, *Jour. Mar. Biol. Ass.*, Vol. IV., p. 293.

† *Jour. Mar. Biol. Ass.*, Vol. V., 1898, pp. 172–175.

‡ Matthews J. D.: *S.F.B. Rep.*, IV., p. 61; V., p. 295.

§ Heincke, F., *l.c.*

Table IV.—Dorsal Fin.

Region.	Sex.	No. of Specimens.	Average of Frequencies.	Frequencies of Rays in Dorsal Fin.																		
				64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82
Aberdeen,	♂	154	72·91	1	–	1	6	–	5	15	15	29	15	20	17	15	8	6	1	–	–	–
	♀	100	72·38	–	–	–	1	5	8	16	11	19	6	11	10	3	4	4	1	–	1	
Grimsby,	♂	60	72·85	–	1	1	–	3	1	8	4	6	6	14	6	6	2	1	1	–	–	–
	♀	60	72·17	–	–	–	1	3	3	8	10	7	11	6	7	3	–	1	–	–	–	–
Lowestoft,	♂	94	72·70	–	–	–	3	2	2	16	14	7	11	14	7	14	2	1	–	–	–	1
	♀	76	72·74	–	1	–	2	1	3	6	13	13	10	9	6	2	5	3	2	–	–	–
Helder,	♂	68	72·15	–	–	1	–	2	4	13	9	13	10	6	1	1	6	2	–	–	–	–
	♀	82	71·83	2	2	–	1	4	9	9	11	11	10	6	8	3	3	2	–	1	–	–
Heligoland,	♂	37	71·60	1	–	1	1	1	3	5	6	8	5	1	1	1	–	2	1	–	–	–
	♀	108	72·61	–	–	1	1	2	7	6	20	17	21	12	7	4	6	2	2	–	–	–
Total,	♂	413	72·64	2	1	3	10	8	15	57	58	63	48	55	32	37	18	2	3	–	–	1
	♀	426	72·37	2	3	1	6	15	30	45	65	67	58	44	38	15	18	12	5	1	1	–

Probable Error or Fluctuation of Average, ... ♂ 72·19—73·09

♀ 71·92—72·82

Body-height. —By this is meant the greatest distance between the dorsal and anal fins measured from their bases. As already mentioned, this dimension is taken in percentage of the total length of the fish minus the length of tail and length of skull. Both by Duncker and Cunningham it has been stated that this dimension was slightly greater in the females than the males. So far as their data is concerned, however, this conclusion is not very evident, and it will be seen from Table XI., p. 230, that such a conclusion can only be drawn with great caution.

In five groups—the males and females of each group being directly comparable as regards size and condition of reproductive organs—only one group shows a clear difference between the males and females in the fluctuations of the averages. This is the group of mature plaice from Aberdeen, which are over 350mm. in length. The fluctuations are 62·50–64·30 per cent. for the males and 65·48–67·88 per cent. for the females. The difference is certainly considerable, being on the average for a fish of 400mm. length about 8mm., or one-third of an inch in favour of the females. The number of specimens in both cases is, however, small, and it may be that this character is not well represented by them. In the other four groups, where the specimens are more numerous, the fluctuations of the averages overlap in each case, although the averages for the males are slightly smaller in all cases than those for the females. From the latter fact there is a certain amount of probability that a slight sexual difference in this character does exist.

In endeavouring to state the amount of this probability it must be remembered that the individuals, the averages of whose characters are here given, represent only a small fraction of the total in the sea, and yet that the probability can only be based on the actually observed values. On account of the former fact some might say that the averages given may not even approximate to the averages that would be obtained from an infinite number. Unless there is collateral evidence to show that the specimens examined are not sufficient in number and are not representative, however, the latter fact—that this is the only kind of evidence we can have—forces us to trust in the amount of probability there is in the results.

As they stand in the Tables the fluctuations of the averages are calculated from five times the probable errors of the averages. This means that if the averages did not overlap, then the probability is a thousand to one that the differences observed correspond to true differences in nature. The four groups in question will not give this amount of probability. If the probable errors are only multiplied by 3, however, then, according to Davenport (*l.c.*), the probability is only 19 to 1. Not one of the four groups in question will give the amount of probability. Again, if the probable errors are multiplied by 2 only, the probability is then 4 to 1 that there are real differences in nature corresponding to the observed differences. But none of the four groups give even this amount of probability. Lastly, if the probable error alone is used the probability is simply 1 to 1. This amount of probability is given by the three groups from the southerly North Sea, but not from the group of immature specimens from Aberdeen. In conclusion, therefore, if the group of mature specimens from Aberdeen be omitted, as being by comparison with the other groups not true representatives of the values of this character, then the probability of there being secondary sexual differences in this character is only 1 to 1—*i.e.*, it is just as probable that there are no such differences.

Length of Skull.—This corresponds to a certain extent with the dimension taken by Duncker and Cunningham, called the "length of the head." This latter was measured externally from "the apex of the lower

jaw to the end of the opercular bone, on the upper side." Owing to the indefiniteness of the latter point, and to the consequent difficulty of taking this measurement accurately, this dimension is not so good or reliable as that taken on the hard skull. This dimension was measured along the ventral aspect from the extreme anterior edge of vomer to the extreme posterior edge of the basioccipital. As with the body-height, it is expressed in percentage of the total length minus the tail and length of skull—*i.e.*, of the "body-length."

Secondary sexual differences are somewhat more evident in this dimension than in the case of the body-height. In all five groups, Table XIII., p. 232, shows that the averages for the males are smaller by ·73 on an average than those for the females, although in only two groups—viz., the mature specimens from the southerly North Sea—are the fluctuations of the averages free from overlapping. If the same process of calculating the probability of the results be gone through here as with the body-height, it is found that the fluctuations of two more groups do not overlap when three times the probable error is employed. Hence, for these two groups the probability of differences existing is 19 to 1. For the fifth group—the mature specimens from Aberdeen—the fluctuations of the average cease to overlap when twice the probable error is employed, and the probability is then 4 to 1. In conclusion, therefore, the probability is, on the whole, in favour of there being secondary sexual differences in this character—being 1000 to 1 for two groups, 19 to 1 for two other groups, and 4 to 1 for the fifth. If an average be struck between these probabilities it may be said that the probability is about 100 to 1 in favour of there being secondary sexual differences.

Two fine points in connection with the working of the method may be mentioned here. It has been shown that the group of mature specimens from Aberdeen were not very representative with regard to the body-height, and this conclusion might be held to vitiate the value of this group in all other characters. This, however, is not so, because the body-height is an extremely variable character, having a wide range of deviations, and is, further, not so true and easily measured a character as the length of skull. Hence, the conclusions formed with regard to the body-height of this group do not apply to other characters.

Again, this group was at variance with the other groups in regard to the body-height, but in regard to the length of skull it is in entire agreement with the others—the greater size of the probable errors and thence of the fluctuations of the averages being really due to the smaller number of specimens. This example shows well how the probability or certainty of our conclusions varies with the number of specimens examined.

It may be mentioned that the only dimension which Heincke found to vary with the sex was the side length of the head, and the difference, in favour of the females as above, was very small, only ·5‰ (*l.c.*, p. 94).

In the other dimensions of the skull, *skull-breadth* and *skull-depth*, Tables XIV. and XV., pp. 233, 234, show that relative to the skull-length there is no sex-variability. The differences in the averages for the males and females are very slight, and sometimes the average for the male is the higher, sometimes that for the female.

It has just been seen, however, that the skull-length is slightly greater in the female than in the male. Hence, the measurements of the skull-breadth and skull-depth partake of this difference when referred to the body-length. The calculation of the exact amount of difference is somewhat complicated, but if approximate values are given to the breadth and depth of skull a very close approximation to the true values can readily be obtained. From the Tables it will be seen that the skull-breadth is

very little less than $\frac{1}{2}$ of the skull-length, and the skull-depth a little more than $\frac{1}{3}$ of the same dimension. The difference between the males and females—viz., ·73—for the skull-length has to be multiplied by these fractions in order to give the approximate amount of difference in the breadth and depth relative to the body-length. The skull-breadth is therefore relatively greater in the females by $\cdot 36^{0}/_{00}$ than in the males, and the skull-depth is similarly greater by $\cdot 25^{0}/_{00}$.

The reason for this difference in the dimensions of the skull between the males and females does not seem difficult to perceive. It is probably connected with the position and mass of the reproductive organs. These are larger in the female and are placed further back than in the male. The centre of gravity in the plaice seems to lie close to the first caudal vertebra, and the male reproductive organs are placed along the hæmal and interhæmal spines of this vertebra, and anteriorly to it, whilst the female organs lie along the interhæmal spines posteriorly. The greater size and therefore mass of the skull in the female would counterbalance anteriorly the greater mass of the reproductive organs posteriorly.

Tail.—Table XII., p. 231, shows that there is very little sex-variability in the length of tail. In the females it is longer in four groups, but in the fifth group the males have a slightly greater length of tail than the females. It is therefore difficult to decide from the observed specimens whether this variability is present in the tail or not. A slight probability tells in favour of the females having the longer tails, and this may be correlated with the differences in the body and skull already described.

It should be mentioned that the length of tail was measured along the longest fin-ray, the median one. The proximal end of the fin-ray is found by bending the fin to the side, and then the point of junction of the fin-ray with the ring of cartilage that terminates the hypural elements is obtained with little difficulty. This dimension is perhaps of little value on account of the variation in size caused by fraying of the distal extremity. This affords another good reason for deducting the tail-length from the total-length of the fish in choosing the standard dimension—in percentage-values of which the other dimensions are expressed.

II. *Growth-variability.*—This form of variability is a much more important factor in giving rise to differences between groups of individuals than is sex-variability, and must be carefully eliminated before conclusions can be made with respect to race-variability. It is, further, a much more complex factor and gives rise to problems extremely difficult to unravel.

Some of these may be briefly referred to. There is, first, the possible difference of age in specimens about the same size, and in the case of some organs, as, for example, the skull, it might be thought that the hardening process or ossification would depend upon age and not upon growth. There seems no clue to the solution of this difficulty for the present, but if it be considered that, so far as known, there is no definite limit to the growth of such parts in fishes—unless we imagine such a limit to be like the limit of a convergent series in mathemathics—and that time or age is therefore of minor consideration, then attention may be directed to the question of change in growth only. Treating the matter more definitely, if we suppose that of two fish about the same size one may be seven years old and the other only five, then our conception of a convergent series in mathematics permits us to disregard the difference in age—because the difference in the size of a part considered as due to this difference of age would be of the third or fourth order of infinitesimals in comparison with the sizes of the parts dealt with—and thence to consider the two specimens as of the same age. In actual observation, also, we are

obliged to follow this course, because we cannot as yet fix the age of a fish by its size beyond the first year or two.

In connection with this question an interesting paper by Reibisch* which has recently been published may be referred to. He endeavours to show how it is possible to tell the age of a plaice by an examination of the otoliths. These, according to his view, grow by successive depositions of calcareous matter, and hence the rings formed at the successive stages may be utilised to tell the age of the fish, just as the successive rings in wood tell the age of a tree. This interesting suggestion came too late for use in the observations recorded in the present paper, but it will not be difficult to act upon it in future.

A further problem arises when the rate of variation in fishes of presumably the same age is considered. If a group of individuals be taken which are alike in the condition of their reproductive organs—*e.g.*, immature males, and which are nearly alike in size—*e.g.*, between 250 and 350mm.—it is found that they differ greatly from one another in every character, and these differences when arranged according to the method of variations give a certain average condition and a certain range of variation round this average. The average condition may be compared directly with the average of other similar chosen groups, but the question at present is to account for the range of variations. With respect to certain characters—*e.g.*, numbers of vertebræ and fin-rays—which, as will be shown, do not vary with growth, the range of variations must arise from influences which are operative on the organism when these parts are in process of formation. These parts are fixed at the earliest stages, when the fish is in the larval and post-larval condition, and the influences that affect their formation are for the most part the surrounding physical and chemical conditions. It might be thought, and it has been stated, that the differences in the amount of food—*i.e.*, of nutrition—may affect the formation of these parts, but it seems to me that such a factor is probably of secondary importance. These parts are not formed in a few minutes, so that the momentary condition of the animal has to be taken into account, but in the course of some days and even weeks. Considering, therefore, that the chances of obtaining food are the same for individuals hatched about the same time, it is possible that the differences in the physical and chemical conditions are of the first importance, and the differences in nutrition only secondary, in causing the variations of these parts.

This question may be left open, however, until further observation and experiment provide more satisfactory data. Under artificial conditions it is probable that the differences in nutrition are the sole cause of differences in growth,† but whether, under natural conditions, such differences in the amount of food obtained by each fish can arise may be doubted.

On the other hand, the differences in the physical and chemical conditions when these parts are in process of formation are well marked. The spawning-period for the plaice extends over three months, from January to March, for the most part, and the average change of the external conditions during those months is considerable, though not yet known very definitely. Hence these differences in the external conditions are perhaps of chief importance in causing the variation in the parts mentioned. It will be said, however, that the organisms which provide food for the young fish are the more abundant the further the season advances, and hence that the difference in nutrition may play an

* Reibisch, T.: "Ueber die Eizahl bei Pleuronectes platessa und die Altersbestimmung dieser Form aus den Otolithen," *Wissen. Meeresunter. Abtheilung*, Kiel, B. IV., 1899.

† *Vide* Cunningham, J. C.: "The Rate of Growth of some Sea-fishes, etc.," *Jour. M.B.A.*, v. II., 1891-92.

important part in causing differences in structure. It is possible, but at the earlier portion of the spawning period, when there is little nutrition to be had, there are also relatively few young fish, and at the later portions of the spawning period, when food is abundant, so also are the young fish. For such parts as the vertebræ and fin-rays, therefore, it is probable that the range of variation which is observed is mostly, if not entirely, due to the physical and chemical conditions.

In the case of other characters, length of fish, length of skull, and so on, the range of variations observed is probably due not so much to the physical and chemical conditions, nor to the differences in nutrition, but to the known difference of age. If the spawning period extends over three months and more, all dimensional parts will show in the range of their variations the effect of this range of variation in the time at which the individuals were born. If two individuals start out on life from the same place and about the same time, then the chances are that they will differ much less from one another than two other individuals which start out on life from the same place but at different times. Hence, the range of variation of any organ at any particular period of life may be considered as corresponding to the initial difference of age. Each period of life, however, has a certain average-condition for each character, and in order to obtain a measure of the growth-variability attention has to be directed to the change in this average-condition and not to the ranges of variation.

The converse problem of variations due to differences in place may be stated here for the sake of contrast. If two individuals start out on life about the same time but at different places, then the chances are that they will differ more from one another than two individuals which begin life at the same place, and the differences between them will be the greater the greater the distances between the two regions. Similarly for time, and if the two individuals in either case which have begun life at some distance from one another are the representatives of many others—of groups, in short—they may possibly represent two distinct races. The further condition necessary is that the offspring of the individuals should arise constantly at similar distances apart from one another as the two individuals mentioned. The external physical and chemical conditions will thus be constantly different, and the differences in the characters which depend upon these conditions will likewise be constant.

It follows from this that racial differences only differ in degree from the differences due, on the one hand, to age or time, and, on the other hand, to place, if it be understood that differences in time and place mean differences in the external conditions. Races may be recognised by other signs, such as differences in the average size at maturity, distinct differences in the times of spawning, distinct regions within which the migrations of the different groups are restricted; but from the examination of characters alone it is evident that certain limits must be ascribed to the ranges of variations due to age and place. The simplest method of picturing how these limits are obtained is that of arranging the different ranges of variations in the form of curves along the same axis. These curves will almost certainly overlap, but the centres of the curves will be at some distance from one another. The question then becomes—What must be the least difference between the centres so that we may say that these centres respectively represent distinct races? According to the method of treating variations already explained, these curves may be taken to represent distinct races if the probable fluctuations of the averages of each group do not overlap.

Before going further it has to be noted that the difference of "age" here spoken of is distinct from the difference of "age" referred to in the first few paragraphs of this section. A reference to the following Tables

will make this distinction clear. In these, the specimens from two different regions are arranged into three groups—immature specimens between 250–350mm. in length, mature specimens of the same length, and mature specimens over 350mm., mostly between 350–450mm. If we consider any one of these groups, say, the immature, then the age of the specimens is uncertain. The individuals between 250–350mm., which are grouped together, may be three, four, or five years old, so far as our present knowledge goes. But this difference for the reasons given may be disregarded. All the groups are alike in this respect and thus directly comparable. On the other hand, the average in each group is the average of a range of variations which, even if we suppose the individuals in each group to be of the same year, have arisen from the initial differences due to age. Hence, in comparing the groups from the two different regions—southerly North Sea and Aberdeen—it is necessary that the probable fluctuations of the averages of the variations due to the latter cause should not overlap if we are to find racial distinctions.

The use of the words "differences due to age" in this sense may appear at first sight a little confusing, but when understood the distinction is of importance and the usage allowable.

If, now, two groups of different sizes, but from the same region—*e.g.*, the mature specimens from the southerly North Sea—between 250–350mm. and 350mm. and above, are compared, it is evident that the differences in the averages are not due to any of the causes yet mentioned. Such differences are usually ascribed to "growth-variability." In the length of the skull, for example, the average size—*i.e.*, the average ratio of the skull-length to body-length—diminishes with growth. This means that at whatever rate the body grows the head does not grow so fast. It follows from this example that it might lead to quite erroneous conclusions if a group of mature specimens between 350 and 450mm. coming from one region was compared with a similar group, but between 250 and 350mm., coming from another region. The differences found might really be due to this growth-variability, although ascribed to race-variability.

It is difficult to say what this growth-variability may mean. Separate explanations have to be given for each character that presents this variability, but in general it may be connected with the balancing of the different organs and structures. The weight of the head, for example, will increase in a greater ratio than will the length of the skull, and it may be, therefore, that the greater rate of increase of the body-length relative to the skull-length is correlated with the rate of increase of the head-weight.

In the discussion of the growth-variability of the various dimensions the influence of maturity will also be mentioned.

Vertebræ and Fin-rays.—In the following Table a collection of 341 plaice from Heligoland is divided up into three lots according to the differences in size:—

[TABLE.

TABLE V.

Growth Variability in Vertebræ and Fin-rays.

M—Average; P.F.—Probable fluctuation of average; No.—Number of specimens.

Length in Mm.	No.	Vertebræ.		Dorsal Fin.		Anal Fin.	
		M.	P.F.	M.	P.F.	M.	P.F.
16- 25	134	43·05	42·95 -43·15	72·45	71·69–73·21	54·31	53·70–54·92
67–300	113	43·03	42·93 -43·13	71·83	71·05–72·61	53·30	52·68–53·92
300-461	94	43·01	42·895–43·125	72·53	71·75–73·31	53·99	53·37–54·61

It is evident that the vertebræ remain the same throughout, because, even when the simple probable error of the average is employed, the fluctuations still overlap. The fin-rays, however, seem to show a decrease and then an increase. In the case of the dorsal fin there is no difference between the smallest and the largest lots, but the fluctuations of the averages between the intermediate lot, from 67–300mm. and those on either side, cease to overlap when twice the probable errors of the averages are taken instead of five times. In the case of the anal fin, the smallest and largest lots are again almost the same, but the averages of the intermediate lot do not overlap with those of the first when four times the probable error of the averages are used, and do not overlap with those of the third lot when twice the probable errors are employed. There would thus seem to be some evidence of a decrease in the numbers of fin-rays during the intermediate stages of growth, but this is counterbalanced by a subsequent increase. This process seems improbable, and it is safer to conclude either that the intermediate lot is not representative or that a difference in the external conditions in the different years has given rise to these observed differences.

Duncker (*l.c.*, p. 174), in his work on the flounder at Plymouth, similarly divided up the specimens into different lots according to size, but although there are slight differences in the averages at the different sizes both for the dorsal and anal fins, they are too small and too irregular to be recognised as differences due to growth-variability. Heincke found also for the herring that there were no such differences, and this seems to be the most reasonable conclusion for the plaice. This point will be referred to again.

Body-height.—A reference to Table XI., p. 230, will show that there is very little growth-variability in this character. The difference that there is tends to show that a slight increase takes place, but it is very slight, and the amount of probability is small. It will be noticed, further, from this Table that maturity has little or no effect on the body-height, the averages for the southerly portion of the North Sea being practically identical, whilst in the case where a difference is shown—viz., in the male specimens from Aberdeen—the probability is very small in favour of a decrease.

Similar conclusions hold for the *Tail* (Table XII., p. 231); the changes in the averages are irregular, and the differences too small to admit of

any probability in favour of a decrease or an increase in length. Maturity also has no effect on this character. Hence, we may conclude that the body-height and the length of the tail do not alter relative to the body-length during growth.

Skull-length.—This dimension, as Table XIII., p. 232, demonstrates, shows a decrease due to growth-variability in all the groups. If the groups of mature specimens alone be considered, then a comparison of three groups between 250–350mm. with other three between 350mm. and upwards is possible. In the first two groups—those from the southerly North Sea—the probability is about 1000 to 1 in favour of a decrease in the relative length of the skull. In the case of the third—the male specimens from Aberdeen—the probability in favour of this decrease is only about 4 to 1, but it will be noticed that the number of specimens is small in comparison with those of the former groups, and this, as already mentioned, lowers considerably the amount of probability.

The decrease is for the three cases ·88, 1·01, and ·36. The average of these is ·75, so that there is a decrease of ·75 per cent. in the length of the skull relative to the length of the body in mature specimens. The difference in the total length of the fish is approximately 100mm., because the average for the specimens between 250–350mm. is 300mm. in both cases, whilst that for those over 350mm. is just a little under 400mm. This decrease in the skull-length, it will be noticed, applies both to males and females.

If the first two columns be now considered, those containing the immature and mature specimens of the same size between 250–350mm., it will at once be noticed that the differences in the averages between the two groups are smaller than were those between the mature specimens at different sizes. The average difference, indeed, only amounts to ·42 per cent., where above it was ·75. Again, if the probability of the observed decrease be calculated, it is found to be 19 to 1 in the first two cases—*i.e.*, those from the southerly North Sea, but only 1 to 1 in the third case—*i.e.*, the male specimens from Aberdeen. Hence, the probability that maturity, or the ripening of the reproductive organs, affects the length of the skull is comparatively small, and the actual decrease observed is small in comparison with that observed as due to growth-variability.

Both Matthews and Heincke found that the length of the skull relative to the length of the body decreased in the herring during growth, but do not give the amount of decrease. The comparison between the herring and the plaice—a free-swimming round fish with a semi-sedentary flat fish—would, on this point, as on many others, be of considerable interest. Such a comparison will be possible later when the promised second portion of Heincke's work appears.

Skull-breadth.—This dimension was measured from the pterotic of the one side to the pterotic of the other, near the posterior extremity. In the plaice the posterior end of the pterotic slopes backwards and inwards to form an articulating surface for the second head of the post-temporal bone of the pectoral arch, and thus presents no definite end-points for measurement. Immediately in front of this articulating surface is the last tubercle on the pterotic, and as this tubercle offers a definite end-point the dimension was measured from tubercle to tubercle. The variations in height of these tubercles are thus included under the variations of the skull-breadth.

As with the skull-length, Table XIV., p. 233, shows that there is a decrease in the breadth of skull relative to the increasing length of body. The proportions given in the Table are relative to the skull-

length, but as this decreases with increase of body-length, the observed decrease in skull-breadth relative to skull-length must be all the greater when considered relative to the body-length. If the groups of mature specimens alone be considered, it is seen that the probability of the observed decrease being real is much less than it was in the case of the skull-length. In the first two cases—those from the southerly North Sea—the probability is about 19 to 1 in the first case and about 4 to 1 in the second in favour of the decrease. In the third case—the group of male specimens from Aberdeen—the probability is again about 4 to 1. The amounts of this decrease for the mature specimens are respectively ·73, ·42, and ·60 in the three cases, which gives ·58 of a decrease on the average. If this amount of decrease, which is relative to skull-length, be added to the decrease of skull-length relative to the body-length, ·75 per cent., and divided by 2 as before, then we find that an approximate decrease of ·66 per cent. takes place in the skull-breadth relative to the body-length as the total length of the fish increases by 100mm.

If the total length of the fish, including tail and skull-length, had been used as the standard and not the body-length, this result, along with that showing the relative decrease in skull-length, would then perhaps have been easier to grasp. A short and simple calculation from the values given will show approximately this decrease relative to the total length of the fish. The length of the tail relative to the body length has been shown to be constant during growth, and practically $30^{0}/_{00}$. The relative length of the skull at 300mm. is—for the southerly North Sea specimen—practically $25^{0}/_{00}$. Hence, since the body-length has been taken as 100, the total length of the fish is 155. This gives the skull-length as $16{\cdot}1^{0}/_{00}$ of the total length of the fish at 300mm. At 400mm., again, the relative tail-length has not altered, but the relative skull-length, for the same groups, has become approximately $24^{0}/_{00}$. Hence, the total length of the fish is now represented by 154, and the skull-length relative to this is $15{\cdot}6^{0}/_{00}$. The decrease in skull-length, therefore, is $\cdot5^{0}/_{00}$ where the increase of total length is 100mm., or, in other words, at 400mm. the skull is 2mm., on an average, shorter than it would have been if there had been no growth-variability. If a similar calculation is gone through for the skull-breadth, it is seen that $\cdot45^{0}/_{00}$ of a decrease occurs, and hence that the skull-breadth is narrower at 400mm. by 1·8mm. than it would have been if there had been no growth-variability.

To return again to the Table, a comparison may be drawn between the immature and mature specimens at the same size. It will be remarked that there is a decrease in each case, but the probability that this observed decrease is real is only 4 to 1. The amount of the decrease is, on the average, $\cdot42^{0}/_{00}$. As was remarked in the case of the former dimensions, maturity, or the ripening of the reproductive organs, seems to have little effect during the first period on the structures observed. It might have been thought that the maturity of the reproductive organs would lead to the withdrawal of nourishment from other parts. This is probably the case, but from what has just been shown its effect seems to be less during the first than during the second period. The difference between the immature specimens with average at 300mm. and the mature specimens with average at 400mm. is, on the average, $1{\cdot}00^{0}/_{00}$, whilst between the former and the mature specimens of the same size it is only $\cdot42^{0}/_{00}$.

Further remarks on the relation of "maturity" to "growth-variability" will be made at the end of next section.

Skull-depth.—This dimension was measured from the commencement of the supraoccipital spine to the middle of the base of the basioccipital

region of the skull. This dimension is not always satisfactory, because the supraoccipital spine is liable to injury. The second point on the base of the skull is fairly well-defined by the markings on the parasphenoid bone, which are left when the pharyngeal teeth are removed. These are attached to the expanded part of the parasphenoid under the basioccipital by strong ligaments, and when the latter are taken away a rough patch on the parasphenoid forms a good end-point. The line joining this to the commencement of the supraoccipital spine passes at right angles to the longitudinal axis of the skull.

Table XV., p. 234, shows that this dimension does not alter either with maturity or with growth. The averages remain practically stationary throughout, and the slight differences there indicate neither increase nor decrease. The depth of the skull, therefore, grows at the same rate throughout relative to the skull-length, but the latter, as has been shown, decreases relative to the body-length by $\cdot 75\,^0/_{00}$, when the total length of the body increases by 100mm. Hence, relative to the body-length the depth of the skull decreases by $\cdot 26\,^0/_{00}$ approximately.

It has been shown, therefore, that for the three dimensions of the skull whose variability is recorded here a decrease in the rate of growth takes place relative to the body-length between 300 and 400mm. If the rates of decrease of the three dimensions considered be taken relative to the total length of the fish, the amounts become ·5, ·45, and $\cdot 18\,^0/_{00}$ for an increase in total length of 100mm. The rates of decrease, therefore, for 1mm. of increase of total length are $\frac{\cdot 5}{100}$, $\frac{\cdot 45}{100}$, and $\frac{\cdot 18}{100}$ or $\frac{50}{10^4}$, $\frac{45}{10^4}$, $\frac{18}{10^4}$. If the skull were a regular six-sided figure, with length, breadth, and depth corresponding to the actual dimensions of the skull, this would mean—neglecting the products of the above fractions—that a relative decrease in volume of $\frac{113}{10^4}$ or about $1\,^0/_{00}$, took place. For such a box this relative decrease would be very small, but in the case of a skull whose volume is only a fraction of that of the box the relative decrease is considerable. It is not simply the volume that is affected, but the weight or mass also, and this must be of some moment. As already mentioned in connection with the relative decrease in skull-length, the reason of the decrease in the skull probably lies in the necessity for a certain constant balance between the weights of head and body always being preserved. On account of the greater mass of the skull relative to the mass of the body, if the dimensions of the head and body increased uniformly together, the head would become relatively much heavier than the body. This would disturb the balance and form of the animal—the qualities most fixed in the species, if anything can be regarded as fixed. In the section on sex-variability it has been shown that the weight of the skull is probably greater in the females than in the males, and this was also explained by the necessity of preserving the balance between head and body. In the herring, again, Heincke has shown that the relative positions of the fins, as well as the length of the bases of the fins, vary during growth, and he has correlated these changes with the movements of the animal, and consequently with the interbalancing of the separate structures and organs.

If we take up now the question of maturity, or the ripening of the reproductive organs, in the light of this conception of the balancing of organs, we see that we have at one and the same time a physiological cause of the changes in the relative positions and sizes of organs during growth, and, on the other hand, a reason for the changes. It has been

shown that the maturing of the reproductive organs hardly affects the relative proportions of structures during the first year, but that later—if 400mm. be considered for the time being as the average-size of a group in the second or later years of maturity—its effect is more clearly marked. Hence, the withdrawal of a portion of their ordinary nourishment from other parts of the body for the sake of the reproductive organs is the direct physiological cause of the relative decrease in size of those parts. And, on the other hand, we see that this relative decrease has a place in the general fitness of things, because the balance of the organism is thereby preserved.

III. *Race-variability.*—After what has been said at the beginning of the section on growth-variability, little further mention need be made of the relationship of racial to the other forms of variability. It has been shown that race-variability differs only in degree from the variability that is present in a single group, and that the relationship between them may be pictured by the aid of curves. If the variations of a large number of specimens be plotted out in the form of a curve—the course of the curve representing the "frequencies" accompanying each "variant," the "variants" being marked off along an axis (abscissal axis)—then three eventualities may arise. The curve may be quite continuous and have only one maximal frequency (*unimaximal curve*), or, again, continuous but with two or more maximal frequencies (*multimaximal curve*). This latter form—if a certain distance, undefined by the author, lie between the maxima—has been taken to represent "discontinuous variation" by Bateson,* but it is clear that the word "discontinuous" is here misused. The different forms of variability give rise to ranges of variation, which grade into one another just as those of the external conditions in the environment are supposed to do, and the continuity of the curve represents this continuous gradation. "Discontinuous variation" is present when the two curves—*i.e.*, the two ranges of variation—do not overlap at all. Such would arise when the variabilities of two widely-separated species—*e.g.*, plaice and herring—were compared.

To return to the consideration of the multimaximal continuous curve, this may arise in the observed variations of a character of a group of specimens in four different ways. Firstly, through *sex-variability.* It has been shown in the section dealing with that subject how a group of specimens, alike as regards age and region from which they came, may show two distinct averages for the variations of a character by reason of a difference between the sexes. If the sexes be taken together, therefore, and the frequencies of the variants plotted along a curve, this curve may present two maxima. Hence, when two different groups are to be composed, it is necessary either to compare similar sexes only, or to calculate, according to Galton's method, a sex-factor for each group so as to eliminate the difference between the sexes.

When sex-variability has been eliminated a multimaximal curve may arise, secondly, through *growth-variability.* This appears in the changes of the relative proportions of parts and organs during growth and maturity. When two groups of specimens otherwise alike, but one about 300mm. in length on the average, the other about 400mm., are compared, it has been shown that the averages of the variations in certain characters are not the same, and we may thus have a multimaximal curve when these variations are arranged in this form. Hence, if two groups of specimens are examined for racial differences, it is necessary either to compare the specimens of the same size in the two groups, or, as above, to calculate the growth-correction or factor so as to bring all the specimens to the same size.

* Bateson, W.: "Materials for the Study of Variation," Introduction; 1894.

When these two forms of variability have been eliminated a multimaximal curve may still arise from two causes—variability in time or age and variability in space. Both of these are included under the term *race-variability*, and it has already been shown that the difference between them and the latter is in each case only a matter of degree. Age or time-variability arises from the prolonged spawning period of a fish. An individual born at the beginning of this period cannot be exactly the same as an individual born at the end of the period. This is probably the chief cause of the range of variations in a character. If the spawning period has only one maximum, as is believed to be the case for each group of plaice, then it is improbable that a multimaximal curve of variations will arise from this cause. In the case of the herring, however, Heincke has shown that a large group of individuals inhabiting the same, or nearly the same, region may be divided up into two separate groups on account of this age-variability. Although connected by intermediate stages, there are, for example, two maximal spawning-periods for the herring of the east coast of Scotland, and in correspondence with this it is found that the averages of the variations in certain characters of these two groups are distinct from one another, although the ranges of variations overlap. Hence, we see how age-variability grades into race-variability and how a unimaximal may become a multimaximal curve. The degree at which the one passes into the other can be determined from the inspection of characters only by the method of probability already illustrated.

Again, multimaximal curves of variation and race-distinctions may arise from differences in geographical distribution, or space-variability. Individuals born at the same time but in different regions will differ more in their characters from those born at the same time and in the same region, and the wider apart the regions are the more likely are they to give rise to race-differences. The latter, therefore, arise from the former by differences of degree only.

It is this latter form of variability that has been found in the plaice, so far as observation has gone. It should be remembered, however, that race-variability does not necessarily arise from the time and space differences. Accompanying these must be other factors whose exact importance in any one case is not yet known. It is not difficult to see that the environmental conditions must differ just as much as the characters before race-differences can be said to be present, but this is not all. The characters of one generation in one local form may differ from those of the same generation in another local form; yet if these differences do not remain from generation to generation we are hardly justified in talking about "races."

Avoiding the question of heredity, this problem may be stated in another way. We may believe, in opposition to Bateson (*l.c.*), that the environmental conditions may be discontinuous as the "species" may be continuous—in the sense that he uses these words—because the environmental conditions of the whole life-cycle of the species must be considered, and yet the question will still arise, how do the "species" or "races" remain distinct and separate? Are the races "isolated" from one another either in time or space or physiologically by definite barriers? Most biologists who have written on the subject of isolation within recent years have considered that some such barriers were necessary, and Darwin himself, in the later editions of the "Origin of Species," after the effects of inter-crossing were pointed out to him, was inclined to agree with these views. Yet his original conception seems most suited to what we find amongst fishes at any rate. On a widely extended area, such as that occupied by the herring or plaice as species, for example, there need be no definite geographical or other barriers, and yet we can conceive how

distinct races and thence species might arise. The individuals at the extreme ends of such an area may and do differ greatly from one another—in some characters as much as two separate "species" do—and there may be all intermediate stages. On such an area the individuals would probably aggregate into groups, and inter-crossing would be rare, except between contiguous groups. The older notions of extensive migrations amongst fishes are not now maintained, and hence races would spring up simply because the various groups always remained in nearly the same region, or because the spawning-period became extended over a great part of the year, and broke up into two or more maximal periods. It is evident that, so far as the environment is concerned, different races and even species might arise, because the external conditions would not be the same in the different regions or periods, and, again, if the external conditions in any one region remained always about the same average so would the group inhabiting that region.

On the other hand, it might be held that since there are no real and definite barriers in the sea the individuals of one group might pass by some means or another into a neighbouring region at an early stage and there assume the characters of the "race" of that region. This conception has been put forward by Petersen in order to explain the differences in the characters of the Baltic and Kattegat plaice. These differences, as will be shown, are considerable, but even if this interchange does really take place we should only have another example of the great variability of the organism, which would not refute the evidence for "races" in other regions.

The matter is still very obscure, however, and more facts are wanted. There has been a tendency—more especially in England*—to found "races" upon little or no evidence, and without in any way showing what was meant by "races." A few characters were taken, a little difference was found, and "races" were discovered!

In the following pages it will be shown how, after the elimination of the differences due to sex- and growth-variability, a difference determined by probability as before, remains between certain groups which seems due to race-variability as above defined. Whether such differences persist from generation to generation it is of course impossible to tell from the present facts, but other evidence will be shown which inclines one to believe that such is really the case.

The four groups of specimens from the southerly North Sea—*i.e.*, from Heligoland, Helder, Lowestoft, and Grimsby—are all taken together as one. No satisfactory reasons could be found for regarding them as separate. The evidence for this will be given in a later paper. Of course, there may be two or more definite groups or races in this region; it is only that the evidence is insufficient to justify the declaration of such. These four groups, considered as one, are compared with the specimens from Aberdeen, the Solway Firth, the Baltic, and a few from the Kattegat.

Vertebræ.—In the two following Tables the averages and their fluctuations are given for all the regions separately, except the Kattegat. In the first Table the total number of vertebræ is considered; in the second, the abdominal and caudal. That these two do not vary together can be seen at once from the figures for the Baltic. Whilst the average for the abdominal vertebræ in the Baltic specimens is as high as in those from Aberdeen, yet the average for the caudal vertebræ is considerably lower. Indeed, the abdominal vertebræ differ little in the whole region concerned,

* *Vide* Cunningham, T. C.: "On the Peculiarities of Plaice from different Fishing Grounds,' *Jour. Mar. Biol. Ass.*, Vol. IV., 1895–97, p. 315 Garstang, W.: "The Variations, Races, and Migrations of the Mackerel," *Jour. Mar. Biol. Ass.*, 1898.

the lowest average in the Solway Firth specimens being only ·06 less than the highest in the Aberdeen and Baltic specimens. This means that the size of the abdominal cavity is probably the same in all.

The case is different with the caudal vertebræ, and these may be considered before proceeding to the total number of vertebræ. The Table shows that the averages of the caudal vertebræ for the whole of the North Sea differ very little between themselves, the lowest, in the Helder specimens, being only ·125 less than the highest in the Heligoland specimens. The fluctuations of the averages, again, greatly overlap in these, and the only conclusion is that they are all identical in regard to this character. The specimens from the Solway Firth also have an average but little smaller than those from the North Sea, and the fluctuations of the averages overlap as before. On the other hand, the specimens from the Baltic differ greatly from the above. The average differs from the lowest of the others by ·48, and the fluctuations barely overlap. If it be considered that the number of specimens from the Baltic is comparatively small, and that this has the effect of increasing the size of the fluctuations, it may be admitted that a similar number of specimens from the Baltic, as from the other regions, would have reduced the fluctuations of the average so much that they would not overlap those of the other regions.

If we turn to the total number of vertebræ the same conclusions are forced upon us. The average for the whole North Sea is practically 43·00, and very little difference exists between the different regions. Helder has the lowest value, its average being ·1 less than those of the others. The standard deviation is, however, the greatest here, and this causes a bigger fluctuation of the average. Whether, if a much larger number of specimens from Helder was examined, this difference in the averages would remain constant, and thus tend to show that the plaice from Helder were really a distinct group from those of the other regions, it is difficult to say. There is a certain amount of probability, but it is at present small.

TABLE VI.—*Vertebræ.*

Average, M.; probable fluctuation, P.F.; standard deviation, σ.

Region.	No. of Specimens.	M.	P.F.	σ
Heligoland, ...	341	43·032	42·932—43·132	·56
Helder, ...	200	42·90	42·74 —43·06	·675
Lowestoft, ...	170	43·05	42·91 —43·19	·54
Grimsby, ...	120	43·02	42·84 —43·20	·59
Total, Southerly North Sea, .	831	43·002	...	...
Aberdeen, ...	254	42·996	42·882—43·110	·54
Solway Firth, ...	197	42·85	42·71 —42·99	·62
Baltic, ...	47	42·42	41·97 —42·87	1·02

[TABLE.

TABLE VII.

Averages for abdominal (M_1) and caudal (M_2) vertebræ; M_2.P.F., probable fluctuation of M_2.

Region.	No. of Specimens.	M_1.	M_2.	M_2. P.F.
Heligoland, ...	308	12·91	30·12	29·95 —30·29
Helder, ...	200	12·91	29.995	29·845—30·145
Lowestoft, ...	170	12·94	30·106	29·936—30·276
Grimsby, ...	120	12·94	30·07	29·87 —30·27
Aberdeen, ...	254	12·96	30·03	29·905—30·155
Solway Firth, ...	197	12·90	29·95	29·81 —30·09
Baltic, ...	47	12·96	29·47	29·07 —29·87

What has been said concerning the specimens from Helder applies with slightly greater force to those from the Solway Firth. The average is certainly smaller than that of the North Sea, and in such an important character as the vertebræ such a difference has considerable importance. It will be necessary to wait, however, until other characters have been examined before drawing definite conclusions.

For the specimens from the Baltic there can be little doubt of the great difference in the average. Although the fluctuations overlap with some of the other groups, the small number of specimens, as well as the large standard deviation, tend to show their distinctness from the North Sea groups. If the number of specimens were increased with a consequent diminution of the standard deviation the fluctuations would cease to overlap. As it is, the total fluctuation is ·9, whilst the greatest in the other groups is ·36. Again, Duncker (*l.c.*) found that the average for the Baltic was 42·3, which, if allowance be made for the comparatively small number of specimens in both cases, shows that the average is practically constant. He also gives the averages for the Kattegat as 43·0 and for Heligoland as 42·9, which shows that these groups are also fairly constant.

It is fair to conclude, therefore, that the average number of vertebræ remains the same for the whole North Sea and the Kattegat, that the Solway Firth group is perhaps different in this respect, and that the Baltic group is certainly different.

These differences lead to the consideration of what is known concerning the changes in vertebræ. Heincke shows that for the herring there is a difference between the groups of summer- and winter-spawners in regard to this character, the former having a smaller number of vertebræ on the average than the latter. Again, the American writers have shown in detail what Günther and others had previously remarked, that in each of the chief groups of flat-fishes the numbers of vertebræ decrease as we pass from the northerly to the southerly species. These remarkable facts would seem to show that temperature has something to do with the number of vertebræ. In the plaice it has been mentioned that there is no such extended spawning-period in the North Sea as there is for the herring. Further, it is probable that the spawning-period in the northerly North Sea is at its maximum a little later than that of the southerly North Sea. Hence, the difference in the temperature between these two

regions at the spawning-periods may be very small, and thus we can understand the uniformity of the average number of vertebræ over the North Sea. And not only the vertebrae but the fin-rays, whose numbers are correlated with those of the vertebræ, are uniform over the whole North Sea, as will presently be shown.

The temperature is not the only influence, however, that seems to affect the vertebræ. The Baltic herring, like the plaice of that region, have a smaller average-number of vertebræ than the North Sea herring. Similarly, the herring from the Zuyder See resemble those of the Baltic in this character, and it has been remarked that the plaice from this region (Helder) are perhaps distinct from the North Sea. The average number of vertebræ and fin-rays in dorsel and anal fins is somewhat smaller than in those of the North Sea plaice. The difference between these regions and the North Sea is probably more one of salinity than of temperature. On the other hand, again, with the possible exception of the lemon-sole, the flounder is the nearest ally to the plaice in North Sea waters and has probably been derived from it. The essential difference between them lies in the vertebræ and fin-rays, which are, on the average, less numerous in the flounder than in the plaice. The young of the flounder, as is well known,* enter the brackish waters at the stage when the vertebræ and fin-rays are forming, and proceed thence into the fresh-water streams. On the other side we have the lemon-sole, which has apparently been derived from the plaice also, and differs from it mainly in the greater number of vertebræ and fin-rays. The young of this form are not found with those of the plaice and flounder, but seem to seek the deeper waters, where the salinity is greater and the temperature probably lower. The pole-dab (*P. cynoglossus*) shows a further advance in the same direction.

It appears, therefore, that salinity as well as temperature has been one of the factors leading to the differentiation of these races and species. Another factor has also to be taken into account, but the subject is too large and complex to be discussed here, and a consideration of the facts is postponed to a future period.

Fin-rays.—In the two following Tables, IX. and X., are set forth the averages of all the fins, the standard-deviations, and the fluctuations of the averages. As the full discussion of all that is contained in these Tables, as well as in those of the vertebræ, would lead to the consideration of many fine points interesting by themselves but not connected with the scope and object of the present paper, attention will be directed only to the general and obvious differences and resemblances.

Considering, in the first place, the dorsal and anal fins, reference must be made to the supposed differences which Cunningham found in these characters in plaice from Plymouth and the North Sea. As already mentioned, this observer did not calculate the averages of the observed frequencies, much less the probability of truth in his results, but trusted himself to general reasoning. The following Table gives the averages for the number of fin-rays found by Cunningham in the plaice for the different regions. The males and females are included together for the reasons stated in the section on sex-variability.

* *Vide* Kyle, H. M., *Sixteenth Rep., Scot. Fish. Board*, pp. 225–246.

*TABLE VIII.

Region.	Plymouth.	Brown Ridges.	Norfolk Coast.	N.E. of Dogger Bank.
No. of specimens . .	36	109	140	43
Dorsal fin .	72·94	72·98	73·028	72·95
Anal fin . .	54·50	54·05	54·27	54·44

It will be seen that the averages for the dorsal fin are practically indentical in all—the greatest difference being ·088. In the anal fin the difference is larger, being ·45 between Plymouth and Brown Ridges. But these two regions are taken together by Cunningham to represent the southern samples, and Norfolk Coast and N.E. of the Doggar Bank are combined to represent a northern group. The averages for these two groups are 54·16 for the southern group and 54·31 for the northern. If one could form any conclusion, therefore, from the small difference between these averages it would be that the southern group had a smaller average-number of anal fin-rays than the northern, which is exactly the reverse conclusion to that reached by Cunningham by general reasoning.

Turning to the Tables IX. and X., it will be seen that the conclusions reached with regard to the vertebræ hold good also for the dorsal and anal fin-rays. The North Sea groups cannot very well be separated from one another, although the group from Helder shows signs that it may be separate. The differences, however, are too fine, as the fluctuations of the averages show, to admit of a definite probability being stated from the characters as to the actual existence of these differences. It can only be said that the plaice from the northerly parts of the North Sea—*i.e.*, Aberdeen—show a tendency to have more fin-rays than those from the southerly parts. The plaice from the Kattegat† come under the same category as those from Aberdeen.

The plaice from the Solway Firth, again, show slightly smaller averages than those from the North Sea, but the differences are again too small to admit of any great probability that they would constantly be found were more specimens examined. For the Baltic specimens, however, the case is very different. The fluctuations of the averages show no tendency to overlap, and the probability that these differences are really permanent becomes a certainty when the figures given by Duncker are considered. He found the average for the dorsal fin to be 67·6 and for the anal 50·4, both of which lie within the fluctuations of the averages given here.

* Made up from numbers given in *Jour. Mar. Biol. Ass.*, Vol., IV., 1897, pp. 356-357.

† I am obliged to Dr. Duncker of Hamburg for being able to give these values of the Kattegat and a number of the Baltic plaice here. In his paper (*l.c.*) the values were given as symbols, but he has very kindly permitted me to bring them into line with the system used in this paper.

TABLE IX.

Average Number of Fin-rays in the Various Fins (M.), *with Standard Deviation* (σ).

Region.	No. of Specimens.	Dorsal.		Anal.		Left Pectoral.		Right Pectoral.		Left Ventral.		Right Ventral.		Caudal.	
		M.	σ	M.	σ	M.	σ	M.	σ	M.	σ	M.	σ	M.	σ
Heligoland, - -	341	72·27	2·57	53·89	2·10	*10·71	·80	‡11·14	·74	‡5·99	·226	‡5·980	·25	‡20·04	·46
Helder, - - -	200	72·01	2·61	53·65	2·05	10·80	1·22	11·135	1·14	5·980	·222	6·00	·00	20·05	·41
Lowestoft, - -	170	72·73	2·77	53·98	1·91	10·93	·65	11·26	·68	5·994	·077	6·00	·00	20·00	·33
Grimsby, - - -	120	72·51	2·66	53·98	1·88	10·91	·64	11·30	·76	5·984	·124	6·00	·00	20·07	·43
So. North Sea, - -	831	72·34	2·63	53·87	1·96	†10·83	·72	§11·20	·73	§5·989	·150	§5·995	·123	§20·04	·39
Aberdeen, - - -	254	72·69	2·70	54·28	2·09	10·98	·69	11·53	·64	5·985	·121	6·00	·100	20·045	·29
Solway Firth, - -	197	71·91	2·76	54·21	1·78	10·84	·74	11·30	·64	–	–	–	–	–	–
Baltic, - - -	143	67·23	2·71	49·98	2·16	‖ 10·23	·75	‖ 10·59	·73	‖ 6·00	·00	‖ 5·96	·204	‖ 19·73	·58
Kattegat, - - -	51	72·84	3·25	55·06	2·41	–	–	–	–	–	–	–	–	–	·

* 193, † 683, ‡ 194, § 684, ‖ 47 specimens.

TABLE X.

Fluctuation of the Averages of the Fin-rays.

Region.	Dorsal.	Anal.	Left Pectoral.	Right Pectoral.	Caudal.
So. North Sea,	72·03 —72·65	53·64—54·10	10·74 —10·92	11·11 —11·29	19·99—20·09
Aberdeen, .	72·12 —73·26	53·84—54·72	10·835—11·125	11·39 —11·67	19·98—20·11
Solway Firth, -	71·245—72·575	53·78—54·64	10·66 —11·02	11·145—11·455	-
Baltic, - -	66·465—67·995	49·37—50·59	9·86 —10·60	10·23 —10·95	19·45—20·01
Kattegat, -	71·31 —74·37	53·92—56·20	-	-	-

The number of fin-rays in the pectorals leads to the same conclusions.

The groups from the North Sea and Solway Firth cannot reasonably be separated from one another, but the Baltic group is again quite distinct. For neither of the fins do the fluctuations of the averages of the last group overlap with those of the other groups.

The ventral fins show very little variation, but the left ventral fin—*i.e.*, that of the under side—shows a greater tendency towards a reduction than the right. There is no difference in the different groups. In the caudal fin, again, there is more variation than one would expect, and the average for the Baltic group is somewhat under that for the North Sea groups. The fluctuations of the averages show also that the probability is almost 1000 to 1 in favour of the difference being real.

Considering the fin-rays as a whole, therefore, it is clear that the only distinct difference that is demonstrably permanent lies between the Baltic plaice and the plaice from the North Sea; the plaice of the latter region cannot be separated into races by these characters, nor can they be separated from the Solway Firth group.

In comparison with the flounder, the plaice possesses a greater variability in regard to its fin-rays. According to Duncker*, the standard deviation ("index of variability") is for the dorsal fin in the flounder between 2·3118 and 2·4445; in the plaice it is 2·63. Similarly for the anal fin; but the pectorals possess an equal variability in both. This large variability in the dorsal and anal fins shows how precarious any attempt to found "races" on the numbers of fin-rays must be. Even though the averages of two groups differed by one fin-ray the large possibility of variation would show itself in the overlapping fluctuations of the averages. There requires to be a difference of almost 2 in the averages of a large number of specimens of both groups before conclusions can be safely drawn. Further, this great variability probably means that these characters are very sensitive to slight changes in the environment when in process of formation, and if the average of these changes is not the same from year to year, the average number of fin-rays will likewise vary. This has been already referred to in the section on growth-variability, and it probably accounts for the slight difference in the averages given for the dorsal and anal fin by Duncker, Cunningham, and myself.

Those who are sceptical as to the existence of "races" and the possibility of detecting them may perhaps think that this probable change from year to year would explain the differences observed in other characters, and would thence destroy the validity of any conclusions

* *Jour. Mar. Biol. Ass.*, Vol. V., 1898, p. 173.

This is not, however, the case, and the example given tends rather to confirm our faith in the method than to destroy it. By means of the method we are able at once to see where conclusions cannot be drawn, and to give good reasons for not doing so. In the other characters, however, where the variability is not so great, there will not be such changes in the averages from year to year. Again, the fluctuations of the averages, which are calculated from the index of variability, leave room for the possible change in the average.

This objection which might be raised simply lays stress on the necessity of comparing, first of all, the individuals of the same generation—*i.e.*, of eliminating the growth-variability, and then of comparing successive generations in order to see if the differences are permanent—before stating definitely that groups or races exist.

Body-height.—It has been shown that no sex- or growth-variability can be ascribed to this character, and the specimens from the southerly North Sea might all be grouped together and similarly all those from the northerly North Sea. In Table XI., however, the sexes and the different sizes are retained separate, because what applies to any one set is applicable to the other.

Cunningham stated that the body-height was distinctly greater in the northern samples than in the southern, and the adjoined Table shows that such is really the case. Whichever groups we compare, male or female, mature or immature, we find the same conclusion. The average of the differences between five groups is $3{\cdot}91^0/_{00}$, and between none of the groups do the fluctuations of the averages overlap. The average body-height for the southerly North Sea is a little over $61^0/_{00}$ of the body-length, whilst that of the northerly North Sea is a little over $65^0/_{00}$ of the same length. Reducing the observed difference between the two groups to the percentage of the total length of the fish, we find that the northerly North Sea specimens are higher (or broader) by $2{\cdot}6^0/_{00}$ than the southerly North Sea specimens. This means that a plaice from the former region at 300mm. is greater by 7·8mm., or more than a third of an inch, than one from the latter region of the same size, and a plaice at 400mm. greater by 10·4mm., or nearly half an inch.

The average body-height of a small number of specimens from the Baltic is included in the Table for the sake of a comparison. Although there is no great certainty in the conclusion, the body-height of these is less than that of the northerly North Sea specimens, and approaches more nearly the average body-height for the southerly North Sea. This conclusion was also arrived at by Duncker. He found that the specimens from Heligoland were slightly smaller than those from the Baltic in this respect, and the latter, again, were considerably smaller than those from the Kattegat. And his conclusions, although he did not make allowances for growth-variability, are perfectly valid, because, as has been shown here, there is no alteration in this character during growth.

TABLE XI.

Height of Body in Percentage of Body-length.

Region.	Sex.	Immature (250–350mm.)			Mature (250–350mm.)			Mature (350—mm.)		
		No.	M.	P.F.	No.	M.	P.F.	No.	M.	P.F.
So. North Sea .	♀	146	61·46	60·71–62·21	61	61·42	60·52–62·32	84	62·00	61·15–62·85
	♂	48	60·75	59·40–62·10	115	60·76	59·91–61·61	76	61·42	60·47–62·37
Aberdeen . .	♀	61	65·64	64·44–66·84	–	–	–	28	66·18	65·48–67·83
	♂	65	65·48	64·28–66·68	51	64·77	63·37–66·17	36	63·90	62·50–64·30
Baltic . . .	♀	–	–	–	30	62·27	–	–	–	–

There seems to be no other conclusion but that this difference arises from the presence of distinct races in the North Sea. Age-, maturity-, sex- and growth-differences are all excluded, and a probability, which amounts to a certainty, declares that the observed differences represent real differences in nature. We should expect, however, that this character would not be the only one to differ, because this difference in height means a difference in mass, and such a difference must be correlated with other differences in structure if the notion of the balance of organs already stated is correct. It will be shown later whether this is the case or not.

Tail.—It will be seen from the accompanying Table that the length of tail relative to body-length is practically identical in both the northerly and southerly North Sea specimens. Relative to the body-length, therefore, there seems to be no change in this character from any cause. The Baltic specimens seem a little longer in this respect, although the small number of specimens renders this conclusion uncertain. Duncker did not notice any difference, but he expressed this dimension apparently in percentage of the total length of the fish, and such fine differences would not be shown as when the dimensions were taken to the length of body only. An examination of more specimens from the Baltic would therefore require to be made.

TABLE XII.

Length of Tail in Percentage of Body-length.

Region.	Sex.	Immature (250-350mm.)			Mature (250–350mm.)			Mature (350—mm.)		
		No.	M.	P.F.	No.	M.	P.F.	No.	M.	P.F.
So. North Sea .	♀	162	30·51	30·06–30·96	63	29·93	29·18–30·68	84	29·38	28·73–30·03
	♂	49	29·94	28·99–30·89	117	30·02	29·51–30·53	78	28·94	28·29–29·59
Aberdeen . .	♀	64	29·53	28·93–30·13	–	–	–	36	29·89	29·04–30·74
	♂	66	29·21	28·36–30·06	51	29·77	28·92–30·62	36	29·75	28·60–30·70
Baltic	♀	–	–	–	30	31·00	29·95–32·05	–	–	–

Average for North Sea, 29·77.

Skull-length.—It has been shown that this character possesses both sex- and growth-variability, but more especially the latter. It is therefore necessary to compare groups of the same sex and size, and this can readily be done from the Table adjoining.

Considering first the immature specimens, the Table shows that both for males and females there is a considerable difference between the southerly and the northerly North Sea. The latter have a shorter skull-length than the former. The average difference is 1·335‰ of the body-length. The fluctuations of the averages, further, do not overlap in either case, so that the probability of the observed difference corresponding to a real difference in nature is at least 1000 to 1.

A comparison of the male mature specimens between 250 and 350mm. leads to the same conclusion. The difference between the two groups is, however, not so great, being ·82, and the fluctuations of the averages, although they do not overlap, are not so distinct from one another as in the former cases. Yet, from the fact of the fluctuations not overlapping, the probability of the observed difference being real is almost as great as in the above cases. There seems to be a further reduction in the difference between the two groups in the mature specimens above 350mm. The averages of the Aberdeen specimens are certainly smaller than those of the southerly North Sea for both sexes, but the average-difference is only ·37, and the fluctuations of the averages overlap in both cases. In the case of the females, the probability that the observed difference is real is 19 to 1, but in the case of the males it is only 1 to 1. As partial, if not the whole, cause of the overlapping of the fluctuations may be considered the comparatively small number of specimens in the Aberdeen groups.

Regarding the groups as a whole, the southerly North Sea specimens have a longer skull-length than those from Aberdeen, the average-difference for all five groups being ·846, and the probability is greatly in favour of this difference being real. For a plaice of 300mm. this means a difference of 1·7mm. between the two groups, and for one of 400mm. a difference of 2·2mm.

TABLE XIII.

Length of Skull in Percentage of Body-length.

Region.	Sex.	Immature (250–350mm.)			Mature (250–350mm.)			Mature (350—mm.)		
		No.	M.	P.F.	No.	M.	P.F.	No.	M.	P.F.
So. North Sea .	♀	162	25·93	25·68–26·18	63	25·48	25·03–25·93	83	24·60	24·15–25·05
	♂	49	25·24	24·69–25·79	117	24·62	24·22–25·02	79	23·61	23·21–24·01
Aberdeen . .	♀	64	24·50	24·05–24·99	–	–	–	36	24·03	23·38–24·68
	♂	66	24·00	23·60–24·40	51	23·80	23·40–24·20	36	23·44	22·89–23·99
Baltic . . .	♀	–	–	–	30	24·83	23·98–25·68	–	–	–

Again, it is seen that in this character also the Baltic specimens lie between the two other groups, but are somewhat nearer the southerly North Sea group than that of Aberdeen.

Skull-breadth.—The following Table, XIV., shows that in all the groups, both immature and mature, a considerable difference exists between the southerly North Sea specimens and those from Aberdeen with regard to this dimension The average-difference over all the groups amounts to 1·84‰ of the skull-length, the Aberdeen being larger than those from the southerly North Sea. The fluctuations of the averages, again, do not overlap in any of the groups, so that the probability amounts to a certainty in favour of this difference observed being real.

If this difference in skull-breadth be taken relative to the length of body instead of the length of skull, it becomes—taking skull-length as equal to one-fourth of the body-length—·46‰ on the average. Hence, independent of any difference in the skull-length, which has been shown to be less in the northern than in the southern groups, we find that there is an increase in skull-breadth in passing from south to north. For a plaice of 300mm. this difference amounts to ·9mm., and for one at 400mm. to 1·2mm.

We may briefly contrast the difference in skull-length with that in skull-breadth. For plaice of 300mm. the Aberdeen group is less by 1·7mm. in the former character, but greater by ·9mm. in the latter, than the southerly North Sea group. As they stand, however, these two differences are not comparable. The skull-length is more than twice the skull-breadth, so that any change in the former is of the same relative value as less than half that change in the latter. It would therefore appear that the one difference is counterbalanced by the other, or that what has been taken away from the Aberdeen group in skull-length is exactly made up for by an increase in skull-breadth.

A further reference to these correlated changes will be made in discussing the depth of skull. Meanwhile, it may be remarked that the Baltic plaice group is again intermediate between the two other groups, but that its average approaches more nearly to the southerly group than to the northerly.

TABLE XIV.

Breadth of Skull in Percentage of Skull-length.

Region.	Sex.	Immature (250–350mm.)			Mature (250–350mm.)			Mature (350—mm.)		
		No.	M.	P.F.	No.	M.	P.F.	No.	M.	P.F.
So. North Sea, .	♀	154	47·49	47·19–47·79	63	47·05	46·40–47·70	82	46·32	45·72–46·92
	♂	49	47·41	46·76–48·06	106	47·00	46·45–47·55	73	46·58	45·88–47·28
Aberdeen, . .	♀	62	49·05	48·30–49·80	–	–	–	36	48·14	47·34–48·94
	♂	66	49·41	48·71–50·11	51	49·00	48·00–50·00	36	48·40	47·70–49·10
Baltic, . . .	♀	–	–	–	30	47·80	46·65–48·95	–	–	–

Skull-depth.—As in the case of the skull-breadth, the sex- and growth-variability of this dimension does not affect the conclusions that may be drawn from the Tables as they are arranged. The same sizes and the same sexes may be compared directly.

It is seen that in all the groups the averages for the southerly North Sea are much smaller than those for Aberdeen. The difference between the various groups is very much the same in all, varying only from 1·21 to 1·55, and the average amounts to 1·35‰ of the head-length. The amount of probability for the actual existence of these differences is very great, being 1000 to 1 in the first three groups, and but little less than that in the last two in spite of the large fluctuations of the averages in the groups of mature specimens from Aberdeen. These large fluctuations, as already pointed out, come from the relatively small number of specimens in those groups.

When this difference in the skull-depth relative to the skull-length is taken relative to the body-length it becomes ·34. There is thus an increase in the skull-depth of ·34‰ of the body-length as we pass from south to north. For a plaice of 300mm. this difference means an increase of ·68mm., and for one at 400mm. an increase of ·88mm.

We may again compare this increase of skull-depth with decrease of skull-length in the northern plaice. For a plaice of 300mm. the northern group is greater by ·68mm. in skull-depth, but less by 1·7mm. in skull-length than the southern group. But as they stand these two proportions are not directly comparable. The skull-depth is on an average about 38‰ of the skull-length, or a little more than a third, and hence, if a change of 1·7mm. occurs in the skull-length, the proportionate change in the skull-depth should only be ·64mm.

TABLE XV.

Depth of Skull in Percentage of Skull-length.

Region.	Sex.	Immature (250–350mm.)			Mature (250–350mm.)			Mature (350—mm.)		
		No.	M.	P.F.	No.	M.	P.F.	No.	M.	P.F.
So. North Sea,	♀	147	37·58	37·13–38·03	60	37·10	36·35–37·85	80	37·70	37·05–38·35
	♂	47	37·64	36·99–38·29	115	37·88	37·48–38·28	77	37·48	37·03–37·93
Aberdeen, . .	♀	62	39·13	38·38–39·88	–	–	–	36	39·00	37·60–40·40
	♂	66	39·03	38·33–39·73	50	39·20	38·60–39·80	36	38·69	37·89–39·49
Baltic, . . .	♀	–	–	–	30	37·67	36·82–38·52	–	–	–

As in the case of the skull-breadth, therefore, the change in the skull-length is counterbalanced by the change in skull-depth, and the slight difference that occurs is in favour of a relatively greater increase in breadth and depth than in length.

As with the other dimensions which have been considered previously, so with the skull-depth it is seen that the Baltic plaice are intermediate between the southerly and northerly groups of the North Sea, but approaches more nearly the southerly group.

Skull.— We may now endeavour to compare the two North Sea groups with regard to the skull as a whole. It has been shown that as we proceed from north to south we meet with an increasing length of skull, but a decreasing breadth and depth. The skull becomes more elongated, but compressed posteriorly. It is, unfortunately, impossible to say exactly what alteration in mass and volume this change in dimensions brings about, but this should not be difficult to determine later. If we consider the form of the skull, however, how by far the greater proportion of the mass and volume is concentrated posteriorly, and how the elongated parasphenoid, vomer, and ethmoid anteriorly show but comparatively little bulk, it seems reasonable to conclude that the equal "dimensional" variation from north to south is not accompanied by an equal variation in mass and volume. It is more probable that the latter diminishes with the diminution of the breadth and depth of the skull as we proceed from north to south.

If now, along with these results, we consider the changes in the skull arising from growth-variability, we find that the two changes cannot be confused with one another. It has been shown that the relative length of skull decreases during growth, hence it might be thought that the reason for the northerly plaice having a lesser skull-length than the southerly was that they were older, or larger. Even apart from the fact that the same average-sizes, and presumably, therefore, the same average-ages have been compared throughout, this reasoning would at once be refuted on turning to the changes in the breadth and depth of skull. These dimensions, it has been shown, also decrease with age, and should on this line of reasoning follow the change in skull-length and decrease as we go from south to north. On the contrary, however, they increase.

The changes that have arisen from race-variability, therefore, are just the reverse of what have occurred through growth-variability.

The differences that arise in the skull from sex-variability, again, have been shown to be very slight, and tend to demonstrate that the skull is relatively a little larger and heavier in the female than in the male. These differences, however, do not in any way affect the evidence for race-variability, because the differences arising from the latter cause appear both in males and females.

It appears, therefore, that changes arise in the skull from all three forms of variability, and it has been sought to find the reason for these changes in the inferred alterations in volume and mass or weight, and thence in the maintenance of a continual balance between the head and body. Under sex-variability it has been inferred that the greater mass and weight of skull in the female is correlated to the greater mass and weight of the reproductive organs. Under growth-variability it has been inferred that the dimensional relative decrease in the skull accompanying the relatively stationary condition of the body means that the mass and weight of the skull has remained throughout in exact proportion to the mass and weight of the body. Lastly, under race-variability, it has been inferred that although the dimensional changes from north to south balance one another, yet that the mass and weight of the head as a whole in reality decreases. This may be correlated with the changes that occur in the body.

Body.—The changes that occur in this dimension arise solely from race-variability. Nor was it to be expected that changes would arise here from sex and growth variability. If any difference arose in the body from these causes it would be between the dorsal and ventral halves and not in the body-height as a whole. It may be inferred also that the differences lie not only in the greatest body-height, but along the whole length of the body from head to tail. Any great increase in weight, therefore, in the region of the body posterior to the first caudal vertebræ would be partially counterbalanced by the greater weight of the abdominal region.

If we now consider the body-height and skull together we may conclude that the changes in the latter arising from sex and growth-variability are correlated with the ripening of the reproductive organs, but that the changes in it arising from race-variability are correlated mostly with the changes in body-height. It has been shown that the northerly plaice have broader and deeper skulls than the southerly, and this is associated with a greater body-height. In the northerly plaice the skull is larger posteriorly than in the southerly, and this is probably related to a greater development of the opercular and pectoral arches, and of the muscular system round the skull. And it is probable, again, that this greater development anteriorly aids to counterbalance in mass and weight the greater mass and weight of the posterior caudal region in spite of the lesser length of the skull. If, therefore, we regard the balance of organs in the northerly and southerly groups to be still the same, we may picture the difference as one of form. The northerly plaice are rounder fish than the southerly. The body of the plaice has very approximately the form of an ellipse, and the change that has occurred in passing from north to south shows itself in the relative decrease of the minor axis (body-height) and relative increase of the major axis (total length of fish).

If we consider, as is generally believed, that the plaice is descended from a northerly sub-arctic stock, then the change above described has probably been the change that has actually occurred. And this alteration has been the only one—no change, so far as can yet be detected, taking place in the vertebræ and fin-rays. The manner by which the change has actually occurred can only be conjectured. It may be that the earlier or younger condition has become the older condition in the southerly plaice,

and that the decrease in the skull and body is accompanied by a less great development of the reproductive organs than in the northerly plaice.

Again, it has to be noticed that a similar alteration in form has taken place in the Baltic group. This, so far as Duncker's results and those given here allow us to conclude, is more nearly allied in form and proportions to the southerly North Sea group. Yet, on the other hand, accompanying the alteration in form, the Baltic plaice also show a great reduction in the number of vertebræ and fin-rays, and this reduction is probably associated with the decrease in salinity of the waters in which the adults live and the young develop.

We may turn now to the evidence from other sources for the existence of groups or races of plaice in the North Sea. Fulton*, as one of the results of his great work on the migration of fishes and the directions of the currents in the North Sea, has shown that even for the slow-moving plaice there is a definite cycle of changes on the east coast of Scotland. Beginning with the spawning of the plaice off the coasts of Aberdeenshire and Kincardineshire, he has shown that the eggs are drifted along by the surface currents—which are not simply superficial—until the young are found on the southern shores of Scotland. There they pass the early stages of life, probably during two and three years, according to the results of Dannevig (*l.c.*), and then begin a northward migration along the shores until at the end of their third, or perhaps fourth, year they reach as far north as where they were spawned, and thence at the period of maturity they go out into deeper waters to spawn. These facts show how definite is the life-cycle, and in a former paper† it has been shown how the young immature plaice of St. Andrews Bay could be detected as a portion of the Aberdeen group by an inspection of their characters.

The facts displayed in this present paper, along with this life-cycle demonstrated by Fulton, show how the northern plaice of the North Sea are distinct from the southern, and show also that the separation is a consequence of this life-cycle, and requires no barriers of any sort in the sea. It is possible, again, that the plaice off the English, German, and Dutch coasts are similarly divided into groups or races, but there is no satisfactory evidence as yet from either side—that of the life-cycle or that of the characters. It may be that as we pass from north to south the differences in characters between the northerly and southerly plaice of the North Sea shown here gradually diminish, so that the differences in the averages are too small to be detected and spoken of with any certainty. Perhaps with a very large number of specimens these finer differences will show themselves, but for the present we can only say that the groups may be present, and that the life-cycle of the one group may be passed under very nearly the same conditions as the life-cycles of the other groups, so that the characters which vary under the stimulus of those conditions are similarly closely related.

The evidence of a definite life-cycle may likewise be brought to bear upon the problem of the plaice in the Baltic. So far as direct evidence is concerned, Petersen's view that they may spring continually from the plaice of the Kattegat, just as those of the Limfjord do from the plaice of the North Sea, is just as correct as Heincke's that the plaice in the Baltic form a distinct race. But the probability seems to me in favour of Heincke, because we have no evidence that the characters of the plaice can change so quickly, and because the evidence of a race remaining distinct and separate off the east coast of Scotland appears conclusive. The plaice of the Baltic may do so likewise, and the eggs and larvæ that

* Fulton, T. W.: *Eleventh Report, Scottish Fishery Board*, pp. 176-186.

† "Extension of the Method of Treating Variations, etc.," *Natural Science*, Dec. 1899.

are found drifting down the Belts into the Baltic may return later as young to the Kattegat, as Heincke supposes, in a similar fashion as those off the southern shores of Scotland return northwards.

In drawing this section to a conclusion, it may be pointed out how, starting from the characteristics of the groups into which a "species" may be naturally divided, we attain by examples a clear conception of the underlying theoretical meaning of the term "race." This has been shown by Heincke with reference to the herring, and his definition adequately displays this inner meaning—"A race is a collection of individuals which live within like surroundings, and which through the intermingling of the sexes stand in close blood relationship." This definition gives a picture of the "race," and the observations recorded here show that such collections of individuals may and do exist.

Conclusion.

At the end of the section on the "average age at first-maturity," the usefulness of the results therein obtained was discussed, and it is now advisable to give a brief review of the contents of the succeeding sections on variability. In such an abstruse subject it is somewhat difficult to explain the theoretical and practical bearing of the work, although the underlying current of thought and relation of part with part may be comprehensible. The chief endeavour throughout has been to utilise and display those portions of the mathematical method of treating variations which are most essential in fisheries research. The work of past observers in Scotland, England, and the Continent has shown that many problems in connection with the fisheries can never be satisfactorily solved until large quantities of material from different places and different times have been examined. The reason for this lies in the great variation displayed by everything. One cannot rely upon a few scattered observations here and there, but must be prepared to amass the facts, not only by the hundreds, but by the thousands.

When the facts have been collected they have to be sorted into groups, and the average value of each group must be calculated. Even this is not sufficient. It is necessary to remember that a thousand facts represent only a fraction of the possible millions in nature, and the amount of probability that the averages of the observed facts represent the true averages must be calculated. As with all new subjects and methods, the work is at first extremely laborious. The calculation of the averages and of their true worth is comparatively easy; the labour arises from the need of carefully selecting and arranging the groups so that no confusion may arise later, and that the conclusions may be justified and self-evident.

In the preceding pages only a few of the total number of characters examined have been described because of the time taken to find the best manner of grouping the facts. As arranged at present each Table serves three purposes. Sex-, growth-, and race-variability can be read directly from any of them without confusion, and this has seemed the shortest and simplest method of arranging the groups. With greater quantities of material it would be possible to sub-divide certain of the groups still further, as, for example, those displaying growth- and race-variability, and finer conclusions might then be drawn. With the material in hand, however, the groups could not be further sub-divided. The characters chosen are perhaps the best for all purposes, but some of the others may be of importance. The latter will be considered at a future date, it is hoped, along with various other points of importance which have only been lightly referred to in the present paper.

It has been shown in these pages how the relative dimensions of various parts of the body—*e.g.*, the skull—may vary with sex, age, and in different regions. The exact amount of the changes observed have been stated, but the conclusions have not been pressed too far. It is believed that the changes in the dimensions are only the superficial evidences of what remains constant throughout. The various structures and organs are so bound up with one another that any change in the one may be accompanied by changes in others, but these relative changes mean that a certain balance of the organs is constantly maintained.

How this balance of the various organs and structures is to be expressed according to the mathematical method of treating variations is still an unsolved problem. The correlation of two, and even three, structures can be displayed by Pearson's and Duncker's methods of treating correlation, but this only shows the amount that one part varies in company with another; or the correlation of the averages may be worked out by Heincke's method, and this is perhaps the nearest approximation to a solution of the problem that has yet been made. This shows how an extreme variation in one part of an individual may be counterbalanced by variations in other directions of other parts. But, apart from the inherent difficulties in connection with the method, this leaves us in the end with facts illustrative of the simple statement that there is a balance of organs. In the present paper it has been shown that the balance is most probably one of mass or weight about a certain point in the body, which may be called the centre of mass or gravity. The changes in the relative dimensions have been referred to the need of preserving constantly this balance It therefore follows that in order to express the balance of organs they must all be reduced to the same common denominator—that of mass or weight. The practical, as well as the mathematical, difficulties in the way of expressing this balance are very great, and all that can be done at present is to show that the solution lies in this direction.

Under the section on race-variability it has been demonstrated that a "species" may be naturally divided into groups, which under normal conditions may have no connection with one another. The practical bearing of this lies in the possibility of telling where any given specimens have come from. The fisherman with long experience is often able to do this almost at a glance, and there is no reason why the naturalist should not be able to do the same in his laboratory. The necessary requirement is that the relative values of the characters at different ages and sizes should be tabulated for the various groups. This should be done for all the common species of food-fishes. The actual need of this has not yet been felt in the case of the marine forms, but cases have arisen amongst the fresh-water forms, such as the trout, where knowledge acquired by the present method would have been invaluable. We cannot tell either when such knowledge of the marine forms, especially of the herring, cod, and plaice, may be required. It simply means that we should be able to distinguish between the different groups of a species just as we are at present able to distinguish the species, although the latter is not at all easy in many cases in the present condition of our knowledge.

A further important aspect of the practical bearing of this study lies in the ability that arises from it to track a certain group through the sea. If the characters of a certain race—say those of the plaice of the northerly North Sea—have been carefully tabulated and differentiated from those of neighbouring races, we should be able to follow these plaice wherever they went. This has already been illustrated in a previous paper. Heincke has shown it also in the case of the Bohuslän herring, and there seems little doubt that it is only lack of definite knowledge that prevents our doing so in other cases as well.

We may turn now to the theoretical consideration of the conclusions that the plaice as a species is divided naturally into several groups, and we may endeavour to answer the question how these groups have arisen. We may believe that they have sprung from a more primitive form which inhabited the sub-arctic regions. Migrating southwards, they have gradually spread out over the comparatively shallow areas of the temperate zone, penetrating to wherever the conditions were suitable to their habits of life, and as they reached the successive regions their characters slowly altered.

Such seems to have been the progress of events, but we do not know how the changes have been wrought. In the case of the Baltic groups the evidence seems almost conclusive that the direct action of the changed environment has effected the changes in vertebræ and fin-rays. These are formed in the early post-larval stages, and in some way that we do not yet understand the decrease in salinity and the increase of temperature in the surrounding waters have brought about a decrease in the number of vertebræ and fin-rays. Correlated with this decrease the average size of the adults has also decreased, and the relative proportions of the various organs and structures have altered in the same directions as those of the southerly North Sea plaice.

In the case of the North Sea plaice we find that there is no appreciable change in the number of vertebræ and fin-rays, and we may thence conclude that the range of variations and the averages of the salinity and temperatures over the whole North Sea are approximately the same during the periods that these organs are developing. This belief is strengthened when we find that the plaice of the south-west coasts of Scotland* possess the same average number of vertebræ and fin-rays as those of the North Sea. These probably come under very similar conditions of salinity, and possibly also of temperature.

It is evident that careful records of temperatures and salinities over these different areas are much needed for such a work as this, where fine differences in characters are sought for.

On the other hand, it has been shown that the North Sea plaice are divided into at least two groups by definite and distinct differences in structure. These differences show themselves in alteration of proportions, such that the plaice of the southerly North Sea are relatively more elongated and narrower, where those of the northerly North Sea are shorter but broader. The plaice of the latter region are more massive, where those of the former are more slender. It has been shown that in all probability this change has taken place without any alteration of the balance of the various organs—*i.e.*, the centre of mass or balance of the animal remains the same. This has been shown to be the case also with the relative changes in parts which arise from sex- and growth-variability. If we suppose that this balance is constant for the species, then the alterations in the relative proportions of structures due to sex, growth, or race are evidences of the various possible combinations of structures and organs which may arise from the specific variability of the organism.

* Dr. Fulton informs me that the salinity of the Solway Firth is certainly lower than that of the North Sea, though actual statistics are not to hand. The plaice from the Solway are therefore comparable rather with those from the Helder than with those of the North Sea, because those from Helder are reared most probably in the brackish waters of the Zuyder See. The values of the averages for these two regions (*vide* Tables VI., VII., and IX.), with the exception of those for the anal and right pectoral fins, are also more akin than with those for the North Sea. It may be, as already suggested (p. 77 and elsewhere), that plaice from both these regions are distinct races, *i.e.*, distinct from those of the North Sea, but other characters than the fin-rays must be more closely examined. The evidence given in this paper shows that for the plaice the averages of the vertebræ and of the fin-rays do not materially alter except under very marked differences in salinity, as, for example, in the case of the plaice in the Baltic.

The question then appears—How have these alterations in the relative proportions of the North Sea plaice arisen? Why should the specific variability of the organism not give rise to the same relative proportions over the whole area? Two formal answers are ready to hand, both of which take for granted that certain differences must exist in the surrounding conditions. On the one hand, natural selectionists would have it that these relative proportions of structures and organs are "adaptive"—*i.e.*, that each combination has been selected by its environment as the best fitted for the conditions around. On the other hand, we might say that the differences in the environment have directly caused the differences in the proportions. The various combinations of the proportions are all adapted, it might be said, to the environment, and natural selectionists can suggest no reason why the one combination should appear in one place and another combination in another.

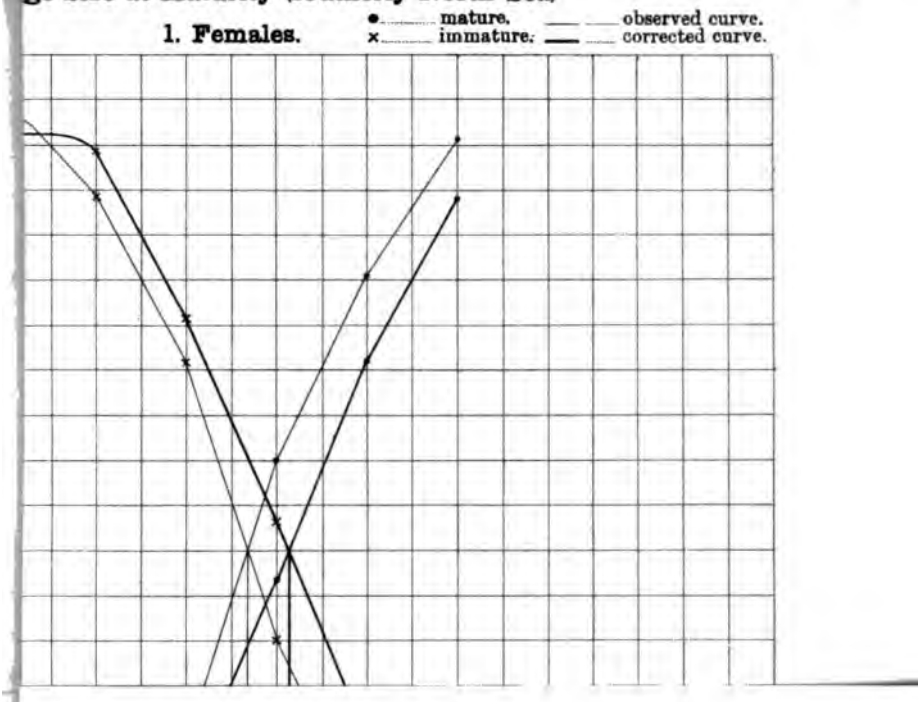
Many arguments might be brought forward in favour of both of these formal explanations, but as they are based only on circumstantial evidence* any discussion is premature. It is profitable, however, to consider whether these alterations in the proportions of the North Sea plaice may not have arisen under exactly similar external conditions. We have accounted for the changes in the Baltic plaice. The environment is different there from that of the North Sea. But in the plaice of the latter region we have not the same evidence for differences in the environment. In the former case the average numbers of vertebræ and fin-rays were greatly reduced, and these were connected with a decrease of salinity and an increase of temperature. In the latter case the average numbers of vertebræ and fin-rays remain the same over the whole region, and we might thence conclude that the average salinity and temperature remained also the same. We have no reason, further, to conclude that the remaining external conditions—pressure, physical and chemical constitution of the water, food supply—are in any way different in the regions referred to. They may be, but we lack evidence.

If the conditions are the same, how may we account for the alteration in the proportions of the northerly and southerly North Sea plaice? A possible explanation may be found in the action of man. The southerly regions of the North Sea have been more rigorously fished for centuries than the northerly regions. Various effects of this rigorous fishing have been already mentioned. The number of large specimens decreases, the average size of the mature specimens is therefore lowered, and possibly also the average-size when they become ripe for the first time. The effect of this would probably be that the specimens which survived would be of a younger type than formerly. Now, it has been shown that in certain respects the plaice of the southerly North Sea might be taken for younger specimens of those of the northerly North Sea. The differences which contradict this are shown in the smaller relative body-height and correlated dimensions of the skull in the plaice of the southerly North Sea. It has been demonstrated also that these dimensions are correlated with the development of the reproductive organs, and if the above reasoning holds good we should expect that the smaller body-height and correlated parts are accompanied by less developed reproductive organs. In other words, the selection practised by man, "natural" in a sense, would have the effect of reducing the size of the reproductive organs, and in order that the balance of the organism may be maintained, the other organs vary concomitantly.

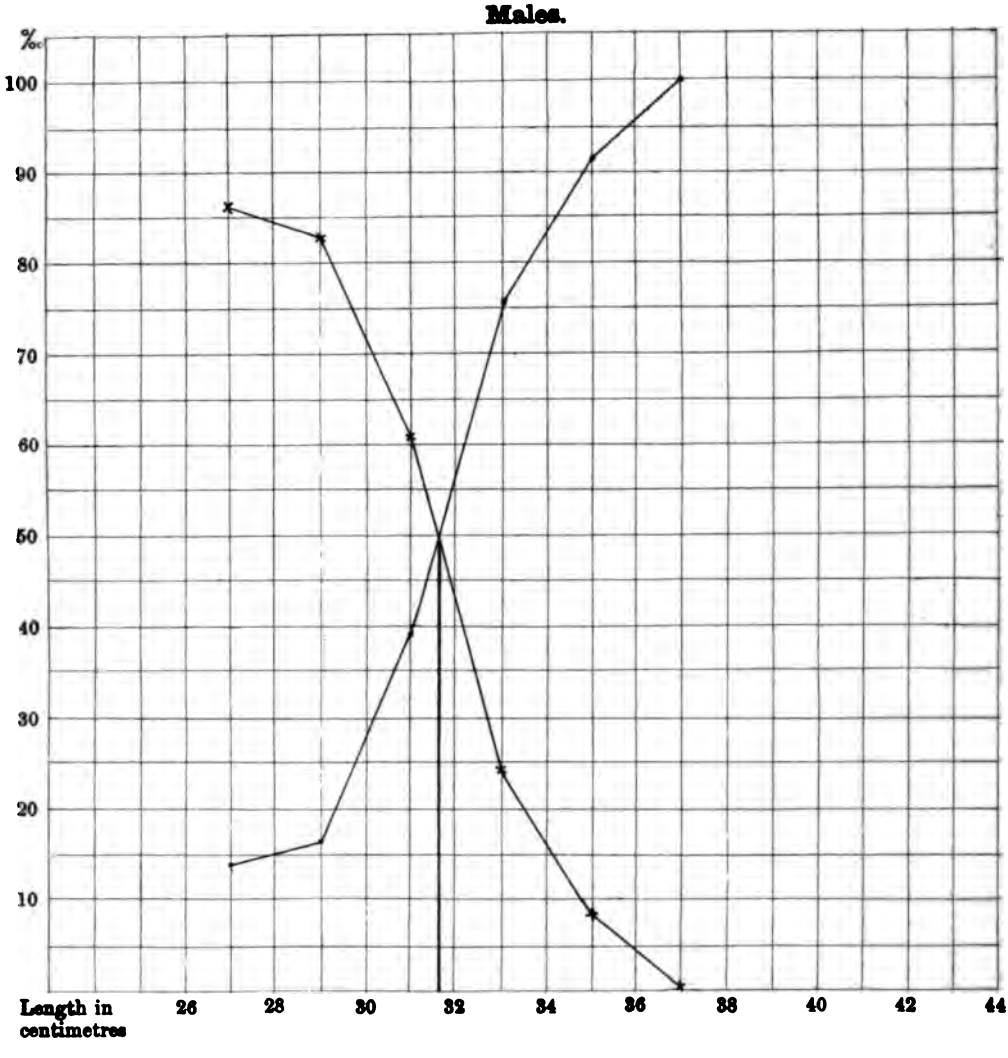
* We might take the work of Bumpus on the sparrow (Biol. Lectures, Woods Holl, Boston, 1898) as direct evidence in favour of natural selection. Weldon's conclusions with regard to *Carcinus mœnas* are not so evident. On the other hand, although we find many definite examples in favour of the direct action of the environment in botany, there seems to be only one in zoology—viz., the change of *Artemia salina* to *Artemia milhausenii*.

ge-Size at Maturity (southerly North Sea)

1. Females.



Average-Size at Maturity (northerly North Sea).
Males.



We thus have three possible and plausible explanations of the alteration in the combination of characters in the plaice. The evidence required to bring us nearer to a more exact explanation will come from two directions. We require a more exact measure of the reproductive fertility—mass of reproductive organs, or number of eggs—in the different regions, and thence some notion of the so-called "reproductive selection"* within those regions, and at different ages or sizes. Secondly, we require some knowledge of the meteorological, physical, and chemical conditions over the North Sea area, together with a more exact determination of the seasonal fluctuations and their averages in the life-cycle of the plaice, especially of the southerly regions.

* *Vide* Pearson, K.: "Chances of Death," 1897.

V.—REPORT OF AN ENQUIRY ON THE ACTION OF THE HERRING SEINE-NET.

By T. Wemyss Fulton, M.D., F.R.S.E., Scientific Superintendent.

Introduction.

In recent years complaints have been made respecting the alleged injurious action of the seine net used for the capture of herrings in Loch Fyne and off the coast of Ayrshire, and the results of an enquiry on this subject are contained in the following report, especially as concerns the capture of immature herrings and the destruction of herring spawn deposited on the bottom. The investigation was begun some years ago at Ballantrae Bank, but owing to the failure of the fishing there in successive seasons, its progress was delayed until the present year, when the herrings returned in considerable numbers. This method of fishing for herrings has formed the subject of legislation and of several previous enquiries which must be here alluded to.

The seine net appears to have been first introduced into the Scottish herring fishery about the year 1838, when it was employed in Loch Fyne. Its use gradually extended, and it became known locally as the "herring trawl," the system of fishing being called "trawling for herrings"; but these terms are improper, since the net is in reality a seine, without a distinct "cod" or pocket, and not a trawl. By the year 1846 or thereabouts the seine had come into pretty common use in Loch Fyne, and disputes and conflicts soon arose between the "trawlers" or seiners, and those pursuing the ordinary and time-honoured system of fishing for herrings with the drift net. The drift-net fishermen alleged that the seine or "trawl" was injurious for many reasons; and this opinion being supported by the leading fish curers and merchants, an Act of Parliament was passed in 1851, with the concurrence of the Board of British White Herring Fishery, by which the employment of the seine for catching herrings was made illegal, the only net recognised as legal and proper being the drift net with the standard meshes of one inch from knot to knot.*

Under this statute the Board of Fisheries took prompt measures to suppress the use of the herring seine net in Loch Fyne and also in the Firth of Forth, where, being used for the capture of sprats, it also took occasion-

* 14 and 15 Vict., c. 26. An Act to Amend the Acts relating to the British White Herring Fishery. Section 6 was as follows:—"That whenever the herring fishery is commenced or carried on it shall not be lawful for any person to use for the purpose of taking herrings any drag net, or sea net mounted for trawling, or any sweep, circle, ring net, or scringe net, or any net prohibited by the said recited Acts or any of them, or any net of any kind or description whatsoever other than the usual drift net, or to use any drift net by dragging the same through the water in the manner of trawling; nor shall it be lawful to take or have on board of any fishing vessel or boat, during the time of the herring fishery, any net of any description other than drift nets; and every such net other than drift nets, used as aforesaid, or found on board of any fishing vessel or boat during the herring fishery, or found on shore, or in the possession of any person for the purpose of being so used, shall be liable to be seized by any superintendent of the herring fishery, or person acting under his order, or by any officer of the fishery; and any person using or having on board any fishing vessel or boat, or having on shore for the purpose of being used as aforesaid, any net contrary to the provisions of the said recited Acts or any of them, or this Act, shall be subject and liable to the penalties imposed in that behalf by the said recited Acts or any of them, and any net so seized shall be liable to forfeiture in terms of the said Acts."

ally considerable quantities of young herrings. The difficulties in enforcing the Act were, however, very great. The trawlers or seiners resorted to all sorts of shifts and expedients to carry on their operations while avoiding detection. When pursued they usually cut the net adrift, or threw it overboard, and the mere seizure of the nets found in the water had little effect in repressing the practice. The naval superintendent in command of H.M.S. "Porcupine," with a crew of 60 men, reported that "although he had unlimited authority under the Act to put down trawling, he had not been able to do so, and that more force was required even to suppress it in the confined area of Loch Fyne," which, however, it was impossible to grant him.* In 1852 the Act was carried out, as far as possible, with great vigour, and 1853 was also "a year of repression," but it was less effective, partly in consequence of an unfortunate accident which occurred from firearms having been used on board one of the boats of the "Porcupine," engaged in enforcing the Act, whereby a fisherman was wounded. The gunner and one of the marines were tried at Inveraray for this offence, and were sentenced to three months' imprisonment, afterwards commuted. In 1854 the outbreak of the Russian war caused the gunboat to be withdrawn; the Act fell largely into abeyance, and the use of the seine revived in 1855 and 1856.†

The Board of Fisheries declared that the Act "had not been found to work satisfactorily," owing to certain defects in it which were specified,‡ and a Commission of Inquiry on the duties of the Board of Fisheries, which was appointed by the Lords of the Treasury in 1856, also examined into the working of the Act and reported against it. "The Act," they said, "has failed to accomplish its object, and has been unfortunate in its consequences. The difficulty of obtaining the legal evidence necessary for conviction has given complete immunity to offenders, whilst the successful continuance of unlawful conduct has tended to familiarise men with law-breaking, and to demoralise them. The evidence of all parties concurs in declaring that trawling is as openly and extensively practised as if it were legal; but the fact is also established that the amount of herrings actually caught in Loch Fyne has largely increased. . . . We earnestly recommend the repeal of a Statute which has no other result than to keep a considerable population in the habitual and successful violation of the law." § In consequence of this report the subject was brought before the notice of the Government with the view of dealing with it by legislation, the Act meantime remaining only nominally in force.‖ Then an event occurred which hastened action. In the autumn of 1858 the shoals of herrings, which had for a long period been absent from upper Loch Fyne, made their way up as far as Inveraray (the headquarters of the drifters), and they were followed thither by the seine boats which brought on a collision between the two classes of fishermen. In 1859 the same thing happened, and the drift-net fishermen then combined to put down seining; they took arms into their boats and threatened to enforce the Act for themselves.¶ The authorities thereupon circulated notices that trawling for herrings was illegal, and they stationed a gunboat and fishery officers in Loch Fyne so as to preclude any trawlers from passing up beyond Otter Spit into the upper loch.

* Report by the Commissioners for the British Fisheries for 1859, p. 5.

† *Ibid.* for 1853, p. 6; for 1859, p. 5. Report on the Herring Fisheries of Scotland by Buckland and Walpole (1878), p. 2.

‡ Report by the Commissioners (1859), p. 4.

§ Report by Messrs. Bonamy Price and St. John and Admiral Sullivan (1857).

‖ Report of Commissioners for the British Fisheries for 1859, p. 5.

¶ *Ibid.*

The operations of the Act in connection with the sprat fisheries in the Firth of Forth also caused great difficulties. There was no legislative restriction against sprat fishing *per se*, but when young herrings were captured—as they very frequently were—by the small-meshed sprat seines, the nets were seized by the fishery officers, and the fishing brought to a stop. When the Board of Fisheries revived the enforcement of the Act in 1859 the sprat fishermen resisted its application to them. They took steps to obtain legal interdict; they assailed the fishery officers with stones, riots occurred, and the commander of H.M.S. "Lizard" reported that he could not carry out the Act without arming his boats, and if he did so, that he could not be responsible for the lives of the people. The "imminent risk of conflict and bloodshed" was such that the Lord Advocate took upon himself the responsibility of advising the Board to stop the seizure of nets and to fix a boundary within which the sprat fishermen might be allowed to fish with the seine; which was done.* The Board of Fisheries, while strongly in favour of a liberating Act, were of opinion that the prohibition of seine trawling should not be simply repealed, as was recommended by the Treasury Commission. They desired that the power of regulation should be conferred upon them, so that they might permit or forbid seining for herrings according to the circumstances of any particular place or case.† In a Bill introduced into the House of Commons by the Lord Advocate, it was accordingly proposed to give such powers to the Board while repealing the existing statutory prohibition. But owing to a strong and widely-extended agitation by fish-curers and merchants, the opposition to this proposal in the House of Commons was so great that the Bill emerged from the Legislature with provisions against seine-net fishing for herrings still more absolute and stringent than those contained in the Act of 1851.‡

The Act of 1860 was enforced, as far as it could be, in Loch Fyne and the Firth of Clyde by the aid of two gunboats and a strong staff of police on shore, but the efforts to suppress seining were "still attended with difficulty" and "were found ineffective." The illegal net was the only article that could be seized, and as the trawlers were ready to sacrifice it for the sake of making their haul of herrings, by cutting

* *Ibid.* Report on the Herring Fisheries of Scotland, by Buckland and Walpole, p. 2. Report of the Commissioners on the Sea Fisheries of the United Kingdom, Vol. II., p. 579 (1866).

† Memo. by Mr. Bouverie Primrose. *Ibid.*, and Vol. I., App., p. 47.

‡ 23 and 24 Vict., c. 92. An Act to Amend the Law relative to the Scottish Herring Fisheries, 1860. Section 13 is as follows:—"For the purposes of the provisions of the sixth section of the Act fourteenth and fifteenth *Victoria*, chapter twenty-six, the herring fishery shall be held to be carried on whenever herrings are being caught, and every net, other than drift nets, which, in the opinion of such Commissioners, may be used for the purpose of taking herrings in contravention of the said Act, shall during the whole time of such herring fishery be removed and laid aside, or shall be liable to be seized and forfeited, and the owner thereof to be proceeded against accordingly; and the finding of any such other net in any open place, and not removed and laid aside as aforesaid, shall be held *prima facie* evidence of the purpose of the possessor of such net to use the same in contravention of the provisions of the recited Acts or of this Act; and unless such possessor shall prove to the satisfaction of the Sheriff, Justice or Justices of the Peace, or magistrate, before whom he may be prosecuted, that such net was not intended to be used for any such unlawful purpose, such net shall be forfeited and destroyed, and the possessor thereof shall be liable in the penalty imposed by the sixth section of the said Act; and, in addition to any superintendent or person acting under his orders, or any officer of the fishery, every constable or officer of the police of any county or burgh acting under the authority and orders of the Sheriff, or any Justice of the Peace, or magistrate of such county or burgh shall, for the purpose of enforcing the provisions of the sixth section of the said Act, have, within such county or burgh, the power to seize any such net in order to the condemnation and forfeiture thereof; and, on the requisition of any superintendent or other officer of the fishery, any constable or officer of police shall be entitled to assist and co-operate with him or them in the execution of this Act." Section 14 declares the mode of obtaining warrants to search for and seize illegal nets, the enforcing of fines and penalties, &c.

away their nets when chased, they in many cases escaped personal identification, and carried off their cargo with impunity to market.* By the aid of a strong force the sprat fishing in the Firth of Forth was completely suppressed. But as "the winter was excessively severe, the sprat fishermen, deprived of their ordinary employment and means of livelihood, became extremely impatient and restless." They raised an action for interdict in the Court of Session, and lost it; and ultimately, owing to the excitement and distress caused by the enforcement of the Act, the Home Secretary advised the Board of Fisheries that if they "should come to the conclusion that the Act in certain localities produced consequences detrimental to certain classes of fishermen, and not contemplated by the Legislature, they would be justified in abstaining from the enforcement of it in those localities, until time should be afforded to Parliament for considering the provisions in question."† An investigation was therefore made by the late Lord (then Dr.) Lyon Playfair and Vice-Admiral Dundas, both members of the Board, into the condition of the sprat fishermen and the effect of their fishing on the herring fishery; and as a result of it sprat fishing with the seine net was allowed to be resumed within a specified boundary.

Since it was found by the Board of Fisheries that the powers conferred upon them by the Acts of 1851 and 1860 were insufficient to enable them effectually to suppress seining, another Act was passed in the following year providing not only for the seizure and forfeiture of the seine net, but of the boats using it, as well as the fish they might contain. Power was also given for the suspension of the prohibition against the seine net when it was employed in sprat fishing within a specified part of the Firth of Forth. The Board were also authorised to employ the police, and under the provisions of the Police (Scotland) Act a fishery police was established.‡ These provisions enabled the law against seining for herrings to be carried into full effect, "with marked results in the suppression of trawling and all other illegal modes of fishing." Many seizures were made and the boats and fishing gear condemned. Another unfortunate occurrence took place in Loch Fyne in 1861 which forcibly drew public attention to the trawling legislation. A fisherman was shot dead by a marine in one of the superintending boats, acting under the orders of his superior officer. The officer and marine were tried before the High Court of Justiciary and acquitted.§

By these Acts seining for herring was almost entirely suppressed in 1862; the seiners joining drift-net boats or getting drift nets for themselves. A great impetus was thus given to the building of drift-net boats and the making of drift nets, and it almost appeared as if the use of the seine in the herring fishery would be permanently abandoned. ||

But in August 1862 a Royal Commission was appointed "to enquire into the operation of the laws relating to trawling for herrings on the coasts of Scotland, having special reference to the Acts of Parliament" which have been cited. This Commission, usually knows as the Playfair Commission, was composed of Dr. Lyon Playfair, Professor Huxley, and Lieutenant-Colonel Maxwell. Their report was presented to Parliament in 1863,¶ and it was of a very thorough character. They summarised the objections raised by the drifters to the seining for herrings

* Report by the Commissioners for the British Fisheries, 1860, p. 3; 1861, p. 3.

† Ibid.

‡ 24 and 25 Vict., c. 72: An Act to make further Provision for the Regulation of the British White Herring Fishery. Report of Commissioners 1861, p. 3.

§ Ibid.

|| *Ibid.* 1862, p. 4.

¶ Report of the Royal Commission on the Operation of the Acts relating to Trawling for Herring on the Coasts of Scotland.

as follows—and the objections have been always of the same nature:—(1) Immature herrings may be caught by it. (2) The seine nets disturb and disperse the shoals of fish in entering the estuaries from the sea, and in consequence the fish desert the waters which they would otherwise have frequented. (3) The seine nets sweep across the beds where the fish are depositing their spawn, and not only take the spawning herrings, but destroy the spawn which has been deposited. (4) Herrings caught by the seine net are not fit for curing, on account of injury received in their capture. (5) The trawlers, or seiners, cut the drift nets and destroy the floats. (6) The two systems cannot be carried on together in narrow waters, as the trawlers get foul of the drift nets and drive away the fish. (7) The extravagant gains of the trawlers, monopolised by a few, alter the market prices by sudden fluctuations, to the great detriment of the drift-net fishermen, who prosecute their labour in a more steady and less gambling manner.

The trawlers, or seiners, on the other hand, denied these allegations, and rested their case on the following grounds: (1) They admitted that when the mesh of the net is less than the legal standard (one inch) they caught immature fish, but they denied that it is their interest to do so, and stated that larger and finer herrings were caught by the trawl than can be got by the drift net. (2) They denied that the enclosure of the herrings in a net drawn gently around them could disturb the general shoal of fish so much as their meeting numerous walls of drift netting. (3) They denied interference with the spawning beds. (4) They declared that seine-caught fish are not only good for the fresh market, which they desired to supply, but also for curing. (5) They denied injuring drift nets, and saw no difficulty in carrying on the two systems of fishing together. (6) They asserted that the large hauls got by the trawlers were of great benefit to the consumer of fish, by enabling him to get herring much cheaper than he could by drift-net fishing.

Besides making personal investigation at Loch Fyne and other parts of the coast, the Commissioners examined the statistics and other evidence placed at their disposal by the Board of Fisheries, which showed that the gross yield of the herring fishing in Loch Fyne had increased rather than diminished, notwithstanding the use of the seine-trawl, and that the same was true of the whole West Coast. "When we look back," they say, "to the records of the fishing in Loch Fyne for the last fifty or sixty years, we find many periods of bad fishing and gloomy depression on the part of the fishermen. In such times of panic they have always been ready to demand legislative protection against other classes of fishermen who were supposed to be interfering with their interests. Thus, in 1836, the Fishery Officer at Loch Fyne, expressing the views of the fishermen there, entreats the Board to protect that loch from ruin, by putting down all fishing on the East Coasts of Scotland during the only months when it was productive, because the West Coast fishermen are persuaded that it is the fish of the West Coast which travel to the East Coast to spawn. In fact, every time that there is a panic, the reasons assigned for the failure of the herring alter, but are strongly pressed upon the Fishery Board as demands for immediate prohibitory measures."

The Commission came to the conclusion that trawling, or seining, for herrings had not been injurious, and had not diminished the productiveness of the fishery in Loch Fyne, which had increased, and that this mode of fishing furnished an important means of cheapening fish to the consumer. They condemned the Trawling Acts. "Although recent legislation," they said, "has been in logicial sequence of that which has

long prevailed, and may, in the absence of new inquiries, have been requisite to prevent disturbance of the peace, still, as it proceeds on the assumption that it is justifiable for the conservation of the breed of herring, we are bound to state that, in this point of view, the repressive Acts of 1851, 1860, and 1861 were altogether unnecessary; that they are essentially Acts for protecting class interests, and interfere with the invention and application of new and more productive modes of industry." They expressed the opinion that if any legislation had been requisite, it should have been applied to a regulation of the size of the mesh of the seines, which were frequently used under the legal standard. But, if seine-fishing were again made legal, they recommended that the Board of Fisheries should have discretionary powers to prohibit it "in waters which are too narrow for that and drift-net fishing being peaceably carried on simultaneously"; and they declared their opinion "that Upper Loch Fyne, *i.e.* above Otter Spit, is too narrow for this purpose, and that the Kyles of Bute offer another instance in which it would be desirable to give the Fishery Board discretionary powers to prohibit the practice of seining, but merely as a question of police."

In the year in which the Report of the Playfair Commission was published, another Royal Commission was appointed to enquire into the condition of the whole sea fisheries of the United Kingdom, and especially as to (1) whether the fish supply was increasing, stationary, or diminishing; (2) whether any methods of fishing in use involved a wasteful destruction of fish or spawn, and, if so, whether it was probable that any legislative restriction upon such methods of fishing would result in an increase of the supply of fish; and (3) whether any existing legislative restrictions operated injuriously upon any of such fisheries. This great Commission, whose labours led to the repeal of so many fishery statutes, was composed of Sir James Caird, M.P., Professor Huxley, and Mr. G. Shaw-Lefevre, M.P., and in 1864 they visited Scotland, and, *inter alia*, enquired into the question of seine-net fishing for herrings. In their Report* the Commission adopted the conclusions of the Playfair Commission. "We are unable," they reported, "to find any satisfactory proof in the evidence that has been brought before us that trawling or circle net-fishing for herrings is, when properly practised, wasteful, or destructive to the brood and spawn of the herring. We are of opinion that it has been and may be a very important means of supplying the market with an abundance of fish; and that, not unfrequently, under circumstances which preclude the capture of herrings by the drift-net fishermen."† With respect to the simultaneous prosecution of the two modes of fishing in narrow waters, they had no doubt that they might be safely carried on in Lower Lochfyne; but they expressed the same opinion as the Playfair Commission as regards Upper Loch Fyne and the Kyles of Bute. In these waters, they said, "there may be difficulties in keeping order among so large a number of fishermen collected together in a comparatively narrow space, and holding very opposite views upon the merits of their respective modes of fishing; but apart from the question of police, we see no reason why both modes of fishing should not be permitted. It is perfectly clear to us that there are times when the "trawl" will take fish, when none can be caught by the drift-net."‡ The conclusion of the Commission on this subject was as follows:—"With respect to the particular case of circle-net fishing on the west coast of

* Report of the Commissioners appointed to inquire into the Sea Fisheries of the United Kingdom. Vol. I. 1866.

†*Ibid.*, p. xlv.

‡*Ibid.*, lvii.

Scotland, we are of opinion that (except in a certain specified locality and as a measure of police) no justification whatever exists for the suppression of that method of taking herrings. There is no evidence that, when properly practised, it is a wasteful mode of fishing; while there is abundant proof that it affords a most plentiful supply of wholesome fresh fish; and that, under certain circumstances of season and weather, the fish thus obtained are not to be captured by other modes of fishing."* They recommend, *inter alia*, that all Acts of Parliament "which professed to regulate or restrict the modes of fishing pursued inshore, should be repealed; with the exceptions, purely on grounds of police, of the local Act regulating pilchard fishing at St. Ives; and, for that part of Loch Fyne which lies above Otter Spit, of the Act prohibiting trawling for herrings in Scotland."†

Effect was soon given to the recommendations of the Commission. The Acts against seine-trawling had been consistently enforced by the Board of Fisheries since 1860; and in their Report for 1866 they state that this enforcement had "given rise to a great change of opinion as to the necessity for continuing to maintain that prohibition," and that, owing to "the unsatisfactory nature of the results produced upon the fishery by their enforcement," and the enquiry held as to their operation, the Government had submitted a Bill to Parliament removing all prohibitions against the use of the seine or herring trawl net.‡ The Act referred to was passed in 1867,§ and the seine-net which had been under legal prohibition since 1851 was again at once employed in Loch Fyne and adjacent waters. "Its restoration," the Board of Fisheries reported, "was received with satisfaction as well by the fishermen of the Upper Loch as of the Lower." Many of the fishermen began to use the drift net or the seine net according as circumstances rendered the one or the other of them the most profitable; and "instead of those bitter hostilities which the suppression of the seine had created, and which had, in former years, on different occasions, led to confusion, riot, and bloodshed, the fishing this past season was pursued in an orderly and quiet manner, and with very marked success."‖ This harmony prevailed so long as the herrings were abundant and the fishing successful; but in seasons when the fishing was poor, complaints were again made against the use of the seine net.¶

In 1877, representations having been made to the Government as to the unsatisfactory state of the Scottish herring fishery, another Commission was appointed by the Home Secretary, "to ascertain whether any legislative regulations would tend to promote the welfare of the fishermen engaged in the said fishery, and to increase the supply of herrings for the benefit of the public." The Commissioners

* *Ibid.* ciii.

† *Ibid.* cvi.

‡ Report of Commissioners, 1866, p. 5.

§ 30 & 31 Vict. c. 52. An Act to alter and amend the Acts relating to the British White Herring Fishery, 1867. Section I. "From and after the passing of this Act, notwithstanding anything in the recited Acts, or any of them to the contrary, it shall be lawful to fish for and take herrings and herring fry at all places on the coasts of Scotland, in any manner of way, and by means of any kind of net having meshes of a size not less than that now permitted or required by law, and to sell, buy, or have in possession herrings or herring fry so fished for and taken; and in lieu of the larger penalties imposed by the recited Acts, or any of them, upon persons using nets having meshes of a size less than that now permitted or required by law, shall for every such offence be liable in a penalty of not less than five pounds, and not exceeding twenty pounds, together with the forfeiture of the net." By the Sea Fisheries Act, 1868, the sections in the Acts of 1851, 1860, and 1861, affecting seine-net fishing, were repealed.

‖ Report for 1867, p. 5.

¶ *Ibid.* 1868, p. 4; 1871, p. 4; 1874, p. 5; 1875, p. 3.

were Mr. Frank Buckland, Mr. (now Sir) Spencer Walpole, and Mr. Archibald Young. The herring fishing in Loch Fyne had greatly fallen off in the years 1872-1875, averaging in that period only 9889 barrels, against an average of 34,655 barrels for the preceding four years, 1868-1871, the catch in 1874 amounting to only 6934 barrels. The drift-net fishermen of Loch Fyne accordingly petitioned that the use of the seine net in the herring fishery should be prohibited at all times and places within a line drawn between the Mull of Galloway and the Mull of Cantyre; and much evidence for and against that mode of fishing was brought forward. The Commission came to the same conclusion as the previous Commissions of 1856, 1862, and 1863. "We think, then," they said, "that trawling involves little, if any, more waste than drift-net fishing; that trawl fishermen are not much more noisy than drift-net fishermen;* and we hesitate to recommend the Legislature to put down a mode of fishing which is admittedly economical, for the sake of securing an indefinite object which is by no means certain of attainment."† But, like the previous Commissions, they recommended that, "as a mere matter of police, it is desirable to prohibit the use of trawl nets (seine nets) in Loch Fyne above Otter Spit, and to give the Secretary of State the power to prohibit the use of trawl nets in other narrow waters less than one mile wide." ‡

The question of the herring-seine was again brought before the Committee of the House of Commons appointed in 1893 to consider the expediency of adopting measures for the improvement of the Sea Fisheries.§ The Committee did not make any specific recommendation, but in the Sea Fisheries Regulation (Scotland) Act of 1895,‖ power was given to the Fishery Board, by bye-law or bye-laws, to prohibit seine trawling in any area or areas within the limits specified in Section 6 of the Herring Fishery (Scotland) Act, 1889, or in the schedule annexed to that section. Anyone contravening such bye-law is made liable to a fine, and every net so set, or attempted to be set, may be seized and forfeited. The powers conferred by this Act do not provide the same facilities for suppressing this mode of fishing as were furnished by the abortive Acts of 1851 and 1860, both of which were found to be unworkable.¶ The power of seizing nets was proved to be ineffective in Lochfyne at least.

In 1893, owing to complaints by Ayrshire fishermen that the use of the seine net was injurious to the herring fishery at Ballantrae Bank, an enquiry was held at Girvan by Mr Esslemont, the late Chairman of the Fishery Board, and it was arranged that an investigation should be made as to the action of the seine net on that spawning ground. As already stated, the fishing in each year, until last year, was a failure, and the investigation could not be made. More recently complaints were made by the drift-net fishermen of Loch Fyne that seine-trawling was proving detrimental to the herring fishery there, and the two areas have been investigated together.

The Methods of Fishing.

The modes by which the herring-fishing is carried on in the Clyde are three in number, namely—by the drift net, the seine net, and the set or

* The noise made by the seiners when working was alleged to frighten away the herrings.

† Report on the Herring Fisheries of Scotland. xxxii. (1878).

‡ *Ibid.*

§ Report of Committee, p. 319.

‖ 58 & 59 Vict. c. 42. s. 9.

¶ *Vide* p. 245.

ground net, locally known as a "trammel." The latter are chiefly used at Ballantrae Bank and the Ayrshire coast, but they are also employed to a small extent in other localities. Many fishermen make use of more than one mode; it is common for the drift net and the seine net to be employed by the same crews at different times, according to circumstances; the former especially when the herrings are scattered, the latter when they are densely aggregated. Each drift-net boat in Loch Fyne is worked by usually three, sometimes only two, men. The nets may number from ten or twelve to eighteen or more in the train or fleet; the meshes range from about 31 to 34 in a yard, and the complete nets may cost £80, while the seine net is much cheaper, costing from £20 to £30 or £34. The drift net is used in the familiar way, floating or drifting as a wall of netting towards the surface of the sea, at a depth which depends upon the length allowed to the buoy-ropes, and which may extend to thirty-five or forty fathoms from the surface. The seine, or so-called "trawl," is said to have been first used in Loch Fyne in 1838, and was then improvised from a drift-net. It is about 150 to 180 yards in length when mounted ready for use, and of the same depth throughout, which may be as much as twenty fathoms, or 120 feet, from top to bottom. It has no "cod" or pocket, but the central part, which is called the bag, differs in having somewhat smaller meshes than the sides or wings, ranging about 35 or 36 to the yard, and they are made of stronger twine, since the pressure is greatest on this part of the net when it is being hauled. In the wings or sides the meshes are about 33 to 35 to the yard.* The rope along the upper edge of the net is corked at intervals of about two feet, and the sole rope is weighted at intervals with leaden sinkers, so that the net when in use floats perpendicularly, the upper edge being at the surface. The bottom, or draw-rope, by which the net is hauled, may be from 200 to 300 fathoms in length. While the drift net is managed by three men from one boat, the seine employs two boats with four men in each, or eight in all. The seine may be used from the shore and in shallow water as in ordinary ground-seining, and is then termed "scringing"; in such cases the net sweeps the bottom, and ground fishes, as plaice and dabs, may be captured. It is also used in deep water when the lower edge of the net is far distant from the bottom, and this is termed "ringing" or "circling." The mode of shooting and hauling is as follows:—When herrings are found one of the two boats passes one end of the rope to the other boat (which remains stationary), and then moves away paying out the net as it goes, and after making a wide sweep or circle returns to the stationary boat. The net is then hauled by the crews, care being taken to prevent the enclosed herrings from striking downward and escaping by drawing the lower edge of the net under them as the circle contracts, and this edge being brought on board, the herrings are contained in a bag formed by the breadth of the net, and are thus brought to the surface. They are then scooped out with baskets into the boat. A varying number of herrings are also meshed in attempting to make their way out through the meshes. Enormous hauls of herrings are sometimes taken with these seines, amounting, it may be, to over 200,000 fish, and the value of a single catch may reach several hundred pounds. The nets occasionally burst from the mass of fish enclosed. On the other hand, long intervals may elapse before a profitable haul is secured.

* The following particulars are given by one of the makers:—*Bag*—50 yards long, 40 score meshes deep, 36 rows to yard, 42/12 ply cotton. *Shoulder*—25 yards long on each side of bag, 40 score meshes deep, 35 rows to the yard, 45/12 ply cotton. *Wings*—75 yards on each side of shoulder, 40 score meshes deep, 35 rows to the yard, 40/9 ply cotton. The whole length is 250 yards, which, when set up in ropes, will hang about 180 yards.

The so-called "trammel" is not a trammel, but a simple set or ground net. It consists essentially of a strip of drift net, sixty to eighty meshes deep, the upper rope being corked and the lower weighted at intervals with stones, each end being anchored and its position indicated by a buoy. The net thus stands erect in the water close to the bottom and rising six or seven feet above it; it is placed across the tide. Two trains, each of about 240 fathoms in length, are usually employed by each boat, and the meshes range about 32 to 34 to the yard. This mode of fishing is effective on spawning grounds in comparatively shallow water, as at Ballantrae Bank, the herrings at the spawning season keeping close to the bottom while engaged in the deposition and fertilisation of the eggs. The "trammels" are left to fish in the sea from day to day, the fishermen at Ballantrae visiting them each morning, if the weather permits, when they are lifted, the herrings removed from them, and again set. In stormy weather the nets may not be visited for several days; they are not infrequently driven away in heavy gales.

The operations of the three modes of fishing in relation to the capture of immature herrings or the destruction of the deposited spawn of herring are these—(1) the drift net floats freely in the water towards the surface or near it, with the meshes open, and the herrings in darting through the water run against it. Small herrings, as those under six and a half inches or thereabout, and many somewhat larger, pass through the meshes and escape being caught, but the larger herrings are meshed, usually behind the gills; very large herrings may not be meshed, or only insecurely by the head. The drift net is therefore not adapted to capture very small herrings, and it secures a greater uniformity in the size of the fish caught than is the case with the seine net. The drift net is set in the evening and hauled at a varying hour in the morning—in Loch Fyne usually about 3 a.m.—and the herrings caught may be alive or dead according to the time they were meshed, and, still more, according to the state of the sea. The buoys at the surface suspending the net rise and fall with the waves, and in a rough sea the upward jerk given to the net proves fatal to many of the herrings. Drift-net fishing can scarcely ever affect deposited spawn.

(2) The seine net when being hauled must also have the meshes for the most part open, as has been shown to be the case with the beam-trawl net; but the strain at certain parts must tend to contract the aperture. In the ordinary course of fishing numbers of small herrings enclosed in the seine must make their escape through the meshes, and many larger herring are frequently meshed in this way. When, however, a large mass of fish is encircled, it is evident that comparatively few of the small herrings which may be enclosed can escape during the time taken to haul the net. In the cases that came under observation the herrings caught by the seine were as a rule alive and vigorous when the net was hauled. The seine net from its mode of operation is therefore adapted to capture greater quantities of young and immature herrings than the drift net. And since the lower leaded edge of the seine may reach to a depth of 18 or 20 fathoms, and in shallow water is dragged along the bottom, its action on a spawning ground within its reach must disturb to some extent and to a less extent destroy herring spawn deposited there.

(3) The set net or "trammel" fishes in the same manner as the drift net, the herrings being meshed by their own movements in swimming about; and the smaller herrings escape capture by passing through the meshes. When used, as at Ballantrae Bank, on a spawning ground, a certain amount of deposited spawn must be disturbed or injured in the process

of hauling and setting the net. It is a common occurrence to find the stones used for anchoring the nets, the ropes, and even the meshes of the net, covered with spawn deposited upon them while lying at the bottom.

Loch Fyne.

The great herring fishing in Loch Fyne extends from the beginning of June to the close of the year, and is carried on by a large number of drift-net and seine-net boats. By far the greater part of the herrings caught are sold at sea to the carrying steamers which frequent the fishing grounds and take the fish for the most part to Glasgow for the early markets. The investigations in Loch Fyne were carried on in the months of June, July, August, September, October, and December during the seasons of 1897 and 1898. The principal points of the enquiry concerned the alleged wasteful destruction by the seine of small immature herrings and of herring spawn. When the "Garland" was in Loch Fyne the seine boats were boarded at various parts of the loch when they were hauling their nets or had just hauled them, and the catches examined and sampled; and by going on board the carrying steamers when the boats were transferring their catches at night or in the early morning. When the "Garland" was not available the night was spent on the steam carriers, and the herring boats visited by means of the buyer's boat, the catches being examined and sampled. On other occasions part or all of the night was spent on board the fishing boats. In the course of the enquiry the catches of many hundreds of boats, amounting to several thousand boxes and some millions of fish, were thus examined, special attention being paid to the presence of young immature herrings among them. The samples taken were measured, and the condition of the reproductive organs and the nature of the food in the stomachs ascertained.

The successive shoals of herrings which enter Loch Fyne are attracted thither by the wealth of the pelagic food which exists there in the summer, and from which they derive their peculiar excellence. It was found that the herrings, especially in the earlier part of the season, fed for the most part on copepoda, almost exclusively on *Calanus finmarchicus*, which is rich in oil and extremely abundant; and later, on the schizopod crustacean *Nyctiphanes norvegica*, and also on the young of their own species, which sometimes form a considerable part of their food. In some hauls twelve per cent., or more, of the stomachs of the larger herrings examined contained young herrings ranging from $1\frac{1}{4}$ inches to $2\frac{1}{2}$ inches in length, and numbering in a given stomach from one to six. Young herrings of the sizes indicated, as well as larger individuals, were also found in the stomachs of bottom white fish caught in the beam-trawl net of the "Garland" in Loch Fyne, *e.g.* in saithe, codling, gurnards, and long rough dabs. Such young herrings were also found in the stomachs of mackerel caught in the herring nets. The loch is thus undoubtedly frequented by shoals of quite small herrings, such as are stated to be sometimes caught and destroyed by the seine net, and it was proved that they may be found at the bottom, as well as at the surface, to depths of at least 74 fathoms. Evidence of the erratic movements of the shoals in connection with their food supply was also obtained. It was sometimes found that almost all the herrings which were examined from one and the same haul had no food in their stomachs; in other cases in the same neighbourhood the opposite occurred, almost all the herrings examined from a haul containing food. In one of these cases where the herrings were caught near the surface

by drift nets in the neighbourhood of Skate Island, at the mouth of the loch, and the food consisted almost entirely of *Nyctiphanes*, a series of tow-nettings was made from the "Garland," which showed that this form was quite absent from the stratum above fifty fathoms; at fifty fathoms a few were caught, while the tow-net fishing at 70 fathoms brought up about a quart. The irregularity of the catches is partly accounted for in this way, small shoals feeding near the bottom in deep water, beyond the reach of drift or seine, and then moving up towards the surface. In experiments which were made from the "Garland" in the deepest water in Loch Fyne, by sinking a large trap, constructed on the principle of a crab-pot, to the bottom, herrings were procured from a depth of 107 fathoms, or 642 feet. The depth of the water in Loch Fyne below the stratum in which the herring nets can be worked, and the abundance of food material in the deepest layers (which are frequented by the herrings), no doubt partly account for the maintenance from season to season of a considerable fishery there, notwithstanding the extensive fishing operations that are carried on. In other lochs on the west coast the fluctuations are far greater and are sometimes phenomenal.

The examination of the reproductive organs also emphasised the importance of the loch as a feeding ground and the mixture of herrings of different degrees of maturity, drawn, no doubt, from many quarters in the neighbouring seas. The great majority were immature, with developing milt or roe, extremely few ripe herrings being found, and these for the most part males. Although it is known that some herrings spawn in Loch Fyne in July and August and later in the year, it is evident that the great bulk of the shoals leave the loch and spawn outside, probably to a large extent in comparatively deep water in Kilbrennan Sound. It is generally believed by Loch Fyne fishermen that Ballantrae Bank forms a spawning ground for the herrings that frequent the loch, but the evidence in favour of this view is far from conclusive. It was also found that the degree of maturity of the reproductive organs varied very greatly among herrings of about the same size, and caught at the same period and place. The following are a few examples:—

Length in Inches.	Weight, grammes.	Weight of Roe, grammes.	Condition of Eggs.
11·6	240·8	58·6	Almost ripe.
11·5	218·4	4·5	Quite immature.
10·0	131·8	10·0	Half developed.
12·3	292·3	9·4	Immature.
13·5	340·0	73·8	Ripe.
10·7	179·9	30·2	Almost ripe.
10·6	175·0	1·3	Immature.

The loch is thus a great feeding place for diverse, more or less mixed, shoals, comprising herrings of all sizes from a little over an inch to over thirteen inches in length, which must reach maturity and spawn at a different period of the year. This mixed quality of the herrings was frequently shown in examining the catches taken by the nets. In all cases considerable range of sizes was found amongst those taken in the same haul, although the degree of admixture varied. Sometimes almost

all were large and of fine quality, with little admixture of herrings of the smaller sizes. In other cases there was a considerable mixture of the smaller herrings. In other instances all the herrings were small. Hauls made by different boats working near one another not unfrequently showed this diversity. Sometimes the larger and better herrings were caught in drift nets, while seine boats working in the neighbourhood got very inferior fish. As has been stated, the largest and smallest herrings found in the hauls were measured, and an estimate was made of the preponderating or average size of the herrings in the catch. The smallest herrings found among the drift-net fish examined were seven inches in length, and the smallest found among the seine-net fish examined were five and a half inches. It was, however, not uncommon to find herrings ranging from six to eight inches among the seine-net catches. The details of some of the hauls are as follows:—

Net.	No. of Boxes of Herrings Caught.	Smallest.	Largest.	Average.
Seine	21	5¾	10¾	8½
,,	38	8½	11¾	9
,,	100	6¼	10½	8½
,,	20	6¾	10¾	9
,,	30	7½	11	9½
,,	16	5½	9½	8¼
,,	131	8	12½	9½
,,	94	8½	13¼	10
,,	246	8	13¼	9½
,,	20	6¾	10	9
,,	9	7	9½	8½
,,	5	8¼	12¾	10
,,	5	6½	9	7–8
,,	6	9	13	10½
Drift	20	8	13	9½
,,	18	7¼	11	8½
,,	10	8½	12¾	10
,,	6	8¾	11½	9½
,,	3	8¾	13¼	10½
,,	7	7½	12	9–10

It is, however, stated that the seine net frequently takes large quantities of smaller herrings than those indicated, and that these are thrown back into the sea; and also that large bodies of small unmarketable herrings may be enclosed by the seine, and although not removed from the net may be suffocated and destroyed in large numbers before they are allowed to escape. Such cases did not come under personal observation, but there is no doubt that large bodies of small, immature, and unmarketable herrings are occasionally enclosed by the seine and hauled to the boat. The seiners say that in such instances, when the nature of the catch is ascertained, the net is loosed and the herrings allowed to escape, and that they escape alive, and can be seen to do so. The drifters assert that in many cases the herrings are suffocated and destroyed and sink to the bottom dead. It is quite likely that this happens to some extent when a large body is encircled and a consider-

able time elapses before the net is hauled. But it does not appear to be a frequent occurrence, so far as could be ascertained by careful enquiry, and from the circumstance that the fishery officer of the district, who was requested at the commencement of last season to notify when cases were reported of the destruction of large quantities of small herrings by the seine net, so that the "Garland," which was working in Loch Fyne and in the Clyde last year, might trawl over the ground for the dead herrings which had fallen to the bottom, did not communicate any such case. In the ordinary use of the seine net it would be sometimes difficult to avoid encircling a body of small fish, but it is obviously not to the interest of the seine-net fishermen to do so, because the labour of shooting, and especially of hauling, the net is very considerable; and when the "fire" in the water is strong the men are usually able to tell whether the herrings are too small to be worth the trouble of shooting the net. One of the chief signs of the presence of herrings, much relied on in dark nights, by which the fishermen are guided in putting out their seine, is what they term "fire," or "firing" or "burning"—*i.e.*, the luminous flash or trail caused by the herring darting through water containing phosphorescent organisms, especially when suddenly disturbed; and while the boat sails about in quest of fish one of the crew is stationed at the bow, peering into the water and striking the front of the boat at short intervals with a mallet, or by letting the anchor fall on the gunwale, to start the herrings in the water below. There are other signs,* but this is a very common one; and it is stated that when the "fire is strong" the fishermen can tell not only the approximate depth and abundance of the herrings but their approximate size. On one of the nights I spent on board a herring boat the time was passed as above described, without the net being once shot, because the herrings were judged to be too small to warrant the trial. The men, it may be stated, were unaware of the object of the visit. But when the "fire" is not "strong," or when other signs have to be depended on, it must happen that bodies of small herrings are sometimes encircled in the way described; and when the net is brought to the side and the nature of the catch discovered the net is slacked and the herrings set free. In other cases, no doubt, these smaller herrings are mingled with marketable fish which are secured and the rest discarded.

Another allegation against the seine net is that by its bursting when a dense body of fish is encircled, or when it is impossible to remove all the herrings enclosed, large quantities of dead herrings sink to the bottom and cause pollution of the water, so that the herrings desert the spot, and may even do so in future seasons. It is not uncommon for rupture of the net to take place under the circumstances mentioned, and in such cases, especially if a considerable time has elapsed, many of the herrings are dead. In other cases herrings may be thrown overboard when they are found to be unsaleable owing to their inferior quality; this often depends upon the quantity of larger fish which may be secured earlier in the night. The same thing may happen with drifters also, and drift nets are sometimes lost owing to the weight of fish they contain. In one case which occurred near the head of the loch the "Garland" afterwards trawled over the ground with a fine-meshed net. In three hauls 48 dead and decomposing herrings were brought up, all

* *E.g.*, "Frying" or "bubbling," caused by the rising of bubbles of gas or "air" from the shoals, and visible when the weather is calm: oily appearance on the surface, no doubt due to excrementitious matters; "playing" on the surface, when the herrings, probably pursued by enemies, rise to the surface and move swiftly, furrowing the water in all directions, the noise produced being comparable to that caused by a heavy shower of rain.

of which were of large size. Whether or not such cases—which, as has been said, sometimes occur also with drift nets and with trammel nets, lost from weight of fish or stormy weather—tend to prevent herrings from frequenting the same grounds when in shallow water has been much discussed both in this country and abroad, and it is frequently assigned as a cause for their desertion. The loss of trammel nets loaded with fish at Ballantrae Bank has been cited by those opposed to the use of the trammel as a reason of the failure of the fishery there. But the explanation is not generally accepted. In the instance in Loch Fyne referred to, it was found that the presence of the decaying herring scattered over the bottom was not detrimental to other fishes, for common dabs, long rough dabs, plaice, codling, gunnel, pipe-fishes, and gobies were brought up in the "Garland's" trawl, as well as numerous invertebrates. The occurrence must happen more or less frequently all over Loch Fyne in every season, and yet the herrings have returned in abundance.

It has been shown that the seine net is adapted to capture quantities of immature herrings that would not be caught by the drift net, and also that it is probable a certain quantity of immature as well as marketable herrings are destroyed by its normal operation in the herring fishery; and it has to be considered whether these occurrences are likely to be detrimental to the preservation of the supply of herrings from Loch Fyne. The capture of immature fish is incidental to all modes of fishing and can hardly be avoided; but if it can be clearly shown to occur to such an extent as to cause a permanent diminution of the supply of the marketable individuals, it is right that measures should be taken to deal with it. So far as concerns the herring fishery in Loch Fyne there is sufficient proof that the continued employment of the seine net over a long period has not proved detrimental in this sense. Seine-net fishing has been continuously and legally pursued since 1867, and has greatly extended since that time, while the supply of herrings has on the whole increased. According to the figures supplied by the fishery officer of the district the estimated quantity of herrings caught in Loch Fyne during each of the ten years 1889-1898 is as follows:—

1889....	26,249 cwts.	1894....	130,721 cwts.
1890....	33,650 cwts.	1895....	63,046 cwts.
1891....	51,887 cwts.	1896....	64,422 cwts.
1892....	50,158 cwts.	1897....	183,309 cwts.
1893....	51,124 cwts.	1898....	131,918 cwts.
	213,068 cwts.		573,416 cwts.

The total catch in the five years 1889-1893 amounted to 213,068 cwts., and in the five years 1894-1898 to 573,416 cwts., or much more than double the quantity. The quantity caught in 1897, viz., 183,309 cwts., is said to be the largest for a very long time. During these years, and ever since the repeal of the Trawling Acts in 1867, trawling or seining has been practised on a very large scale in Loch Fyne and the neighbouring waters, and while great fluctuations have occurred in different seasons, the supply has on the whole been fully maintained. Earlier statistics, prepared mostly in connection with the various enquiries which have been held on seining for herrings, show the

same result.* A table prepared by Mr. Reiach, the late Chief Inspector of the Herring Fishery, for the Commission of 1876 gives information extending over a long period. It is as follows:—†

Ten Years from	Average Number of Boats.	Average Number of Barrels.	Average Number Barrels per Boat.	Minimum Catch in Decade.	Maximum Catch in Decade.
1827–36	300	3,469	11·5	1,453 (1830)	4,898 (1832)
1837–46	350	7,388	25·1	3,225 (1839)	9,400 (1846)
1847–56	396	19,949	50·4	10,630 (1852)	32,726 (1851)
1857–66	558	33,096	59·3	16,151 (1864)	79,893 (1862)
1867–76	479	25,561	53·4	6,934 (1874)	34,471 (1876)

These statistics do not distinguish between the quantities of herrings caught by the drift net and the seine net, but they show a general increase in the catch. There is less information with respect to the relative numbers of drift-net and seine-net boats that took part in the fishery in Loch Fyne, except during the period from 1850 to 1862, when a return was prepared for the use of the Playfair Commission as follows:—

Years.	Seine Boats.	Drift Boats.	Years.	Seine Boats.	Drift Boats.
1850	40	538	1857	121	409
1851	60	518	1858	143	377
1852	55	515	1859	122	409
1853	60	490	1860	90	405
1854	72	475	1861	84	432
1855	103	407	1862	—	772
1856	106	414			

* The statistics as published in the Reports of the Board of British White Herring Fishery are imperfect.

† Report of Commission, p. 134. The quantities (in barrels) caught in each of the ten years from 1867 to 1876 were these:—40,964, 46,813, 43,088, 26,716, 22,005, 11,358, 8,166, 6,934, 15,097, 34,471. In a Table prepared for the enquiry in 1862 (*Report*, p. 8), the years are grouped in different series.

Years.	Barrels.	Maximum.	Minimum.
1834-38	17,869	—	—
1839-43	20,119	—	—
1844-48	15,427	15,560	13,816
1849-53	19,149	32,726	10,630
1854-58	25,744	31,423	16,999
1859-62	42,165	79,893	20,246

As we have seen (p. 242), trawling or seining was made illegal in 1851, but the prohibition was ineffectually enforced, and was in abeyance from 1854 to 1859; it was entirely suppressed in 1862. It would be of considerable importance if statistics were available for a period of years showing the number of seine-and drift-net boats pursuing the fishery, and the quantity and value of the herrings caught by each of these methods of fishing. That the number of seiners has very greatly increased in proportion to the drifters is shown by two returns specially prepared, one in connection with Mr. Esslemont's inquiry in 1893, and the other referring to last year; and they also indicate the quantity and value of the herrings taken by each class of fishermen. The return referring to Loch Fyne for 1893 is as follows:—

	Boats.	Men.	Herrings.	Value.
			Crans.	£
Drift net, . .	135	376	15,030	15,317
Seine net, . .	160	640	25,760	25,200

The statistics for the Inveraray district in 1899 show that while the numbers of both drift- and seine-net boats have diminished since 1893, the latter mode of fishing fully maintains its preponderance. The figures are these:—

	Boats.	Men.	Herrings.	Value.
			Crans.	£
Drift net, . .	105	276	7,847	6,815
Seine net, . .	138	552	23,541	34,074

It is thus evident that during the years since the earlier inquiries were made, the use of the seine net has greatly extended relatively to the use of the drift net; while, as has been shown, the supply of herrings has increased rather than diminished. The corresponding statistics for the adjoining district of Campbeltown for the same years exhibit similar features, the preponderance of seine-net fishing being as marked as in Loch Fyne. The fishermen of each district fish both in Loch Fyne and Kilbrennan Sound.

	Boats.	Men.	Herrings.	Value.
1893.			*Crans.*	£
Drift net, . .	149	447	33,087	24,067
Seine net, . .	132	594	37,763	31,892
1899.				
Drift net, . .	95	320	4,357	6,579
Seine net, . .	140	630	27,541	33,672

The preponderance of the seine-net fishing for herrings in the Firth of Clyde, taken as a whole, is further shown in the following Table for

the years 1893 and 1899, which also includes particulars respecting the trammel-net fishery—a method which is for the most part restricted to the coast of Ayrshire:

	Boats.	Men.	Herrings.	Value.
1893.			*Crans.*	£
Drift net, . .	436	1,279	53,348	45,440
Seine net, . .	352	1,474	63,854	57,449
Trammel net, .	79	250	695	693
1899.				
Drift net, . .	404	1,262	15,965	18,009
Seine net, . .	328	1,382	54,059	70,325
Trammel net, .	22	74	757	751

Thus in 1893, in the whole area of the Clyde, there were, according to the returns of the Fishery Officers, 436 boats and 1272 men employed in drifting for herrings, and 352 boats and 1474 men employed in the seine-net fishing. The herrings landed by the seine-net boats exceeded those of the drift-net boats in quantity by 10,506 crans and in value by £12,009. The average price of seine-net herrings was about 18s. per cran, and of drift-net herrings 17s. 0½d. per cran. Moreover, the average catch per boat of the drifters was 122·3 crans, and the average earnings £104 4s. 5d.; while the average catch of the seine-net boats was 181·4 crans, and the average earnings £163 4s. 2d. The average catch per man of the drifters was 41·7 crans, and the earnings £35 10s. 6d., as against an average catch by the seiners of 43·3 crans and earnings of £38 19s. 6d. per man. In 1899 the difference in favour of the seiners was more marked. While the 404 drift boats landed only 15,965 crans of herrings of the value of £18,009, the 328 seine boats landed 54,059 crans, valued at £70,325. There was thus an excess in favour of the seiners of 38,094 crans and £52,316. The average catch and earnings rose also in proportion.

It is therefore evident that the seine-net fishing for herrings has grown to be of very considerable importance in the Clyde, and that it has largely increased relatively to drift-net fishing since the time when it was alleged to be ruining the Loch Fyne herring fishery, and the Trawling Acts were passed to suppress it; while, at the same time, the supply of herrings for the consumer has been fully maintained.

Ballantrae Bank.

It has already been stated that in consequence of complaints made by Ayrshire fishermen against the use of the seine net on that coast, and especially at Ballantrae Bank, an enquiry on the subject was held at Girvan in 1893. Seine-net fishing was alleged to be wasteful and injurious on the following grounds:—1. That it involves the capture of large quantities of immature herrings, which when brought to shore are found to be practically of no use except for manure; and that in addition large quantities of immature herrings are smothered in the seine nets, and fall to the bottom and are lost. 2. That it is an irregular mode of fishing in the sense that on one day a huge catch may be obtained, which gluts the market, while on the next day no herrings may be caught. 3. That it "breaks the eye of the herring" or "the head of

the shoal"—*i.e.*, it breaks up and scatters the shoals, diverting them from their course to the spawning grounds. 4. When prosecuted on the spawning ground—Ballantrae Bank—it disturbs the herring-spawn on the bottom, and destroys it. 5. That it cannot be beneficially carried on alongside the trammel-net fishing, because it damages the trammel nets in the same way as beam trawling damages the lines and nets of other fishermen; and that since trammel-net fishing is the old and native mode of fishing on Ballantrae Bank, and seine trawling was introduced by stranger fishermen and is prosecuted by them only, it should be prohibited during the months of February and March. It was decided that an investigation should be made at Ballantrae Bank on the action of the seine net, with especial reference to the alleged destruction of the deposited spawn of the herring and the capture or destruction of immature herrings. Arrangements were accordingly made in each year to carry out this investigation, but owing to the repeated failure of the fishing very few seine-net boats carried on their operations there, and the observations could not be made until last year and this, when the herrings returned to the bank in considerable numbers, and seine-net fishing was resumed. The work has been materially assisted by Mr. R. Duthie, the fishery officer of the district, who has at various times given valuable aid to the enquiry.

The herring fishery at this part of the coast is very different from what it is in Loch Fyne. It is prosecuted in February and March by local trammel boats and by seine-net boats, chiefly from Argyllshire, and it is liable to sudden interruption from storms. The great majority of the herrings taken are ripe and spawning; it is a fishery for spawning herrings. The bank, which is of an irregular elongated form, lies off the coast between Bennan Head and the southern part of Ballantrae, and is parallel to it. It begins about one mile from the shore, and extends to a distance of somewhat over three miles from it. The depth of water ranges from about seven to thirteen fathoms, and the bank is composed principally of stones, gravel, and coarse sand. That is the position and extent of Ballantrae Bank proper, although an elevation of the bottom extends more or less from Girvan to Loch Ryan.

The fishery was at one time of considerable importance, and was carried on at the bank and in its neighbourhood by a large number of drift and trammel-net boats, many of which came from distant parts of the coast. From the same influences that caused the Acts to be passed for the suppression of seining, the Ballantrae winter fishing was put a stop to from 1860 to 1868 by reason of clauses in the Acts of 1860 and 1865 establishing a close-time from 1st January (or 1st February in the Act of 1865) until 31st May between Ardnamurchan Point and the Mull of Galloway.* This was done on the supposition that Ballantrae Bank was the spawning ground for Loch Fyne herrings. But after 1868, on the repeal of the Acts, the fishing was resumed, and was frequently very successful. The quantity and value of the herrings caught at the winter fishing off the coast in each of the last twenty-five years are shown in the following Table, with the number of the boats engaged:—

* 23 and 24 Vict., c. 92, s. 4; 28 Vict., c. 22, s. 2.

[TABLE.

Year.	Boats Employed.			Herrings Caught.					
	Trammel or Drift.	Seine.	Total.	By Trammel or Drift.		By Seine.		Total.	
				Crans.	*Value.* £	*Crans.*	*Value.* £	*Crans.*	*Value.*
1876			123					6,071	£13,610
1877			175					10,254	23,625
1878			191					17,830	44,575
1879			304					20,092	50,230
1880			364					31,292	73,536
1881			407					24,294	65,100
1882	152	270	422					8,708	22,770
1883	120	288	408					31,374	78,435
1884	123	320	443					14,564	43,692
1885	111	300	411					27,671	46,673
1886	100	192	292					4,760	5,168
1887	78	100	178					9,876	3,291
1888	65	90	155					9,515	3,983
1889	60	144	204					10,615	4,940
1890	60	114	174	1,608	—	6,586		8,194	5,147
1891	53	172	225	945	—	5,955		6,901	6,391
1892	51	46	97	1,618	—	1,695		3,313	2,404
1893	48	56	104	423	393	31	25	454	393
1894	25	—	25	75	80	—	—	75	80
1895	42	24	66	1,170	1,220	351	417	1,521	1,637
1896	19	6	25	158	40	371	93	529	133
1897	18	2	20	466	295	3	—	469	295
1898	5	—	5	25	20	—	—	25	20
1899	7	32	39	260	93	977	356	1,237	449
1900	28	42	70	1,824	1,428	2,286	1,607	4,110	3,035

These statistics clearly indicate the former importance of this herring fishery and the poor condition to which it has sunk in recent years, which is ascribed by the local fishermen to excessive "trawling" or seining. Prior to 1878 the only methods in use for the capture of herrings at Ballantrae Bank and its immediate neighbourhood were the drift net and the trammel, the former being employed principally beyond the Bank, while the trammels were set upon it. But in 1878 the seine net began to be employed on the Bank by fishermen from Argyllshire, and with so much success, that its use rapidly extended. The quantity of herrings, it will be observed, rose very largely in the years following its introduction, over 31,000 crans being secured in 1880 and 1883, their gross value amounting to no less than £73,536 and £78,435 respectively; whereas in 1894 the quantity taken was only 75 crans, of the value of £80, and in 1898 only 25 crans, of the value of £20. Down to about the year 1884 the largest herrings were secured by the seine net, and in one season the crews of two seine-net boats (eight men) earned in five weeks the sum of £900.* But after the year named the herrings caught were generally much inferior in size, and in some seasons a considerable proportion of the seine-net fish were so small as to be unmarketable, and were in some cases used for manure. It may be stated that the price, as well as the gross value, has greatly diminished of late years. Thus in the ten years 1876-1885 the average price was never under £2 per cran,

* *Fifth Report Fishery Board for Scotland*, p. 434.

it was usually £2 10s., and in one year (1881) it was £2 12s. per cran. In 1886 it had sunk to £1 1s. per cran; in 1890 to 12s. 6d., in 1896 to 5s., and in 1899 it was 7s. 3d.; in only one year since 1890 has the price reached £1 per cran—namely, in 1895. The decline in the price is not, however, chiefly due to the quantity of small herrings landed but to other causes regulating the markets, and principally the development of the winter fishery at other parts of the coast, and the importation of Norwegian herrings.

It is difficult to decide whether or not the extensive use of the seine net has produced detrimental effects on the fishery. It is contended that the great catches in nearly all the years from 1878 to 1885, when the seine net was so largely used, were excessive, and that the shoals of herrings which habitually frequented the spawning ground were either depleted, or so disturbed that they abandoned the Bank, and went elsewhere to spawn. The failure may, on the other hand, be due merely to natural fluctuations, the causes of which are obscure, but which at all events profoundly affect the herring fishery in many localities. Many cases might be cited in which the herrings deserted a favourite ground for years without apparent cause, and as suddenly reappeared. On a former occasion, namely in 1855, the herrings abandoned Ballantrae Bank, and did not return until 1862. Their disappearance then was also attributed by the trammel-net fishermen to the use of the seine net, not at the Bank itself in February and March, but on the northern coast of Ayrshire in December, when the shoals were making their way to the spawning ground. The other classes of fishermen held that it was caused by the excessive use of the trammel net, by which very large numbers of spawning herrings were captured and much spawn destroyed.*

With regard to the capture of small or immature herrings, there is no doubt that the seine net takes far greater quantities than the trammel net does; in this respect the trammel is comparable to the drift net. In seasons when small herrings abound very large quantities have been landed, and in some years have been found unsaleable and used for manure. Sometimes the catch of the seine boats consists of herrings as large and fine as those got by the trammels, but as a rule there is a considerable admixture of inferior fish. If the net is torn on the bottom, which is not an infrequent occurrence, or if a larger quantity is enclosed than the boats can well carry, and part is allowed to escape, the proportion of small herrings in the catch may be increased, inasmuch as large numbers of them are meshed. Herrings of seven to eight or eight and a half inches are not uncommon in the catches of the seine net. It was found, however, that herrings of comparatively small size may be sexually mature and propagating at Ballantrae Bank. Specimens, both male and female, not more than eight inches in length, were occasionally found to be spawning or spent; and many between eight and nine inches were in the same condition. The majority at these sizes were, however, not ripe; and many of them were found to have been feeding on the deposited herring spawn. The question of the pollution of the ground by dead herrings has also been raised in connection with this fishery, but it is probable that the seine-net boats are not chiefly responsible for the presence of dead herrings on the Bank. There is no doubt that, as in Loch Fyne, dead herrings fall upon the ground in the operations of the seine, and much more here owing to the not uncommon tearing of the net by catching on the bottom. But the same thing occurs, and probably to a greater extent,

* Report of Playfair Commission, p. 16. Report Royal Commission, vol. ii., p. 1189, 1190.

from the trammel net. These nets are left in the water, and are usually visited in the morning by the fishermen, who remove the herrings and re-set the net; the boats do not stand by their nets. It often happens that, owing to bad weather, the nets cannot be visited for many days, and they may become so weighted with fish as to lie flat on the bottom; and sometimes a gale sweeps them away or casts them into heaps, and in such cases putrefaction of the herrings contained in them causes pollution of the water. There is no evidence to show that such occurrences have affected the fishing detrimentally in succeeding years, although they have been sometimes adduced as a reason for putting a stop to the fishery on the Bank.

The question whether or not the seine net disturbs or destroys the deposited spawn of the herring was specially investigated during the present year (1900), when a considerable number of seine-net boats resumed the fishing at Ballantrae Bank. By means of the "Garland" Mr. Pearcey was able to visit the boats when they were hauling their nets, and also to make dredgings at various parts of the Bank in order to ascertain the presence or absence of herring spawn at different points. The dredgings showed that, while no spawn existed at certain points of the Bank, it was in great abundance at other parts, and this largely accounted for the diversity of the results respecting the action of the herring seine. The following dredgings may be specified:—

6th March. Ballantrae village bearing S.E. 2¼ miles distant, ten fathoms of water. A small quantity of clean shelly sand and small stones brought up; no deposited herring spawn.

7th March. (1) Ballantrae village bearing E.S.E. 2 miles distant, nine fathoms. Dredge full of sand, stones, gravel, with shells and a few fronds of *Laminaria*, nearly all of which were thickly coated with deposited herring spawn; (2) Ballantrae bearing S.E. ½ S., distant 2½ miles; 9¾ fathoms. Dredge full of sand, stones, gravel, and *Laminaria*, without any trace of herring spawn; (3) Ballantrae village bearing E. by S., 2 miles distant; 9½ fathoms. Dredge filled with sand, gravel, and a few stones (1 to 3½ inches in diameter). Herring spawn thickly deposited on the shingle and on some of the stones.

The number of seine nets which were examined immediately they were brought from the water was 79, of which 63 showed no trace of deposited herring spawn, while in sixteen it was found in more or less abundance, chiefly on the broad fronds of *Laminaria* and the stones at their roots, and fine specimens of the deposited spawn were obtained. All the nets examined, except four, furnished evidence of having come in contact with or swept the ground, on which they sometimes became fast. In most cases stones, shells, weeds, or specimens of bottom-living animals were brought up. A summary of the records made on board the "Garland" by Mr. Pearcey is here given:—

MARCH 1ST, 1900.

1. 5.30 P.M. Net shot in 12 fathoms about 2¾ miles N.E. of Ballantrae. Became fast on bottom, and was got up with difficulty; much damaged. One specimen of *Ophiothrix fragilis* was obtained, net otherwise quite clean. No fish of any kind captured.

2. 6.50 P.M. Near the same locality, in 10 fathoms. Net caught on the bottom and brought up much torn from sole-rope; 1 *Asterias rubens*, 1 stone 2½ inches, taken from foot of net. No spawn recent or deposited. No fish captured.

3. In 10 fathoms. Net got caught on the bottom and was somewhat damaged. One basket of herring captured. No deposited spawn. Net quite clean.

4. In 10¼ fathoms. Net said not to have touched the bottom. No deposited spawn or any bottom-living organisms obtained. Net quite clean. 14 baskets of herring captured.

5. In 9½ fathoms. Net caught on bottom and considerably damaged. Two pieces of rock fragments 7¼ and 5 inches long, 2 *A. rubens*, 2 *Solaster papposus* were obtained in body of net and near sole-rope.

6. 8.30 P.M. In 9¾ fathoms. Net had touched the bottom, sole-rope damaged. Net quite clean. A few baskets of herring captured.

7. 9.30 P.M. In 10 fathoms. Net became fast on bottom and was slightly damaged. No deposited spawn found. Net quite clean. Only a few herring captured

8. In 9½ fathoms. Net caught on the bottom and slightly damaged. Only a few herring captured, otherwise net quite clean.

9. In 10 fathoms. Net had touched the bottom. Nothing found on net or sole-rope. Fully 50 baskets of herrings captured, all ready for spawning.

10. In 9½ fathoms. Net said not to have touched the bottom. Net found to be quite clean. Fully 100 baskets of herring captured, the males giving off milt freely, females about ready for depositing spawn.

11. 10.50 P.M. In 9¼ fathoms. Net had touched the bottom but found to be quite clean. 150 to 200 baskets of herring captured.

12. In 10 fathoms. Net caught on the bottom and got torn from sole-rope. Two rock fragments 8½ and 10 inches, 2 *Ophiothrix fragilis* in foot of net, but no deposited spawn observed. 20 baskets of herring captured, males giving off milt freely and females ready for spawning.

13. In 10½ fathoms. Net caught on the bottom and badly damaged. One rock fragment, 1 *Asterias rubens*, 1 *A. gracilis*, and 2 *Ophiothrix fragilis*. No deposited spawn found; otherwise net quite clean. No fish captured.

14. In 10¼ fathoms. Net caught on the bottom and somewhat damaged, but found to be quite clean. No deposited spawn or bottom-living animals found. 10 baskets of herring captured.

All the trawl boats visited had their nets so prepared that they should drag the bottom, the sole-rope being heavily weighted with lead.

March 2nd—Came up with the herring fleet on Ballantrae Bank at 4.50 P.M.; 40 in number. Shortly after 5 P.M. a number commenced to shoot nets S.W. and N.E. off Ballantrae village, about 1¾ to 2½ miles distant.

15. In 12½ fathoms. Net did not touch the bottom and was quite clean. No deposited spawn found. Two baskets of ripe herring captured.

16. In 9½ fathoms. Net caught on the bottom; examined net carefully and found it to be quite clean, no bottom-living animals of any kind or deposited spawn. Some 20 baskets of ripe herring captured.

17. In 10¼ fathoms. Net had dragged the bottom slightly, but was found to be quite clean. No deposited spawn or any bottom-living organisms found. About half-dozen baskets of ripe herring captured.

18. In 10½ fathoms. Net did not touch the bottom; found to be quite clean. 30 baskets of ripe herring, 2 saithe, and 1 haddock captured.

19. In 9½ fathoms. Net had dragged the bottom slightly, but came up quite clean. 14 baskets of spawning herring were captured.

20. In 10¼ fathoms. Net dragged the bottom slightly, but found to to quite clean. No deposited spawn observed or any bottom-living animals. A few baskets of ripe herring and one cod captured.

21. In 10 fathoms. Net had touched the bottom slightly, but no deposited spawn or any animals from the bottom found; net quite clean. A few baskets of spawning herring and one ling captured.

22. In 10½ fathoms. Net had dragged the bottom a little. Two small stones 2 and 2¼ inches obtained in net, and one *Ophiothrix fragilis* and a few ripe herring; otherwise the net was found quite clean.

March 6th, at 5.30 P.M., the trawl boats commenced to shoot their nets.

23. In 9½ fathoms. Net dragged on bottom a little. One large irregular rock fragment, 12 × 6 × 5 inches, and a smaller piece 5 × 3½ inches, with various bottom-living animals, but no deposited spawn either on these or the net. Eight cod and saithe were captured, but no herring.

24. In 9¾ fathoms. Net had touched the bottom and brought up two fronds of *Laminaria*, with stones attached to roots, but no deposited spawn was found. Only one cod was captured.

25. In 9¾ fathoms. Net became fast on the bottom. One *E. esculentus* and 1 *A. rubens* were found in net, but no deposited spawn. A few herring only were captured.

26. In 10¾ fathoms. Net became fast on the bottom for a time, and was brought up split in several places, but found to be quite clean. Three cod and 2 saithe were captured.

27. In 9 fathoms. Net had touched the bottom; no deposited spawn found. Ten baskets of herring captured.

28. In 8 fathoms. Net became fast on bottom and was badly damaged. Several small stones, 1 *A. rubens*, several *O. fragilis*, 1 *E. esculentus*, and several *Laminaria* fronds found, but no deposited spawn. Net otherwise quite clean. No fish captured.

29. In 8 fathoms. Net had touched the bottom. One *A. rubens* found, but no deposited spawn. Fully 100 baskets of ripe herring captured.

30. In 6½ fathoms, near south edge of Bank. Net had touched the bottom and was slightly damaged. No deposited spawn found, net being quite clean. Fully 40 baskets of herring captured.

31. In 10 fathoms. Net dragged a little on bottom. Two *E. esculentus*, 2 fronds of *Laminaria*, with stones at roots, taken from net near sole-rope, but no deposited spawn found. Three cod and 1 saithe were the only fish captured.

32. In 9¼ fathoms, near south edge of Bank. Net had touched the bottom, but came up quite clean. Three saithe, 2 cod, and 1 haddock were all the fish captured.

33. In 7 fathoms, about 3 miles to the south of Ballantrae village. Net had slightly dragged the bottom; no deposited spawn found. An enormous catch of herring was obtained at first in this haul, so large that the two boats could not manage it, and the assistance of two other boats was obtained, when a great effort to secure the catch was made; but the body of fish was so great and heavy that before any could be taken from the net they again sank to the bottom, and the net split with the strain, all but some 10 to 15 baskets of herring being lost. It appeared to me that most of these fish got clear living and in good condition.

34. In 8¼ fathoms. Net slightly dragged the bottom, but was brought up quite clean; no deposited spawn found on net or sole-rope. Thirty to 40 baskets of herring captured.

35. In 8¾ fathoms. Net dragged on bottom a little. Four stones, largest 2¾ inches; 1 *Buccinum undatum*, with *Eupagurus bernhardus*, a few *O. fragilis*, and 1 frond of *Laminaria* found in net near sole-rope. No deposited spawn; otherwise net quite clean. 25 baskets of herring and 1 saithe captured.

36. In 6½ fathoms, N.E. side of Ballantrae Bank. Net had dragged the bottom slightly, but nothing was obtained from the bottom, and no deposited spawn found on net or sole-rope. Fully 80 baskets of herring captured.

37. In 7½ fathoms. Net became fast on bottom and damaged. A few meshed herring obtained, but otherwise net quite clean.

38. In 6 fathoms, near south end of Bank. Net had touched bottom. Three stones from 2¼ inches to 4¾ inches, a few *O. fragilis*, several fronds of *Laminaria* with gravel attached to roots, 1 *E. escutentus*, 2 *A. rubens* found near sole-rope. No deposited spawn. Fully 60 baskets of herring captured.

39. In 9 fathoms. Net become fast on bottom. Two stones, 3 *E. esculentus*, 2 *A. rubens*, 1 *Laminaria* frond taken from net. No deposited spawn found; net otherwise quite clean. A few baskets of herring captured. This boat shot again near the same spot in 9 fathoms. Net touched bottom, but came up quite clean. Fully 60 baskets of herring captured.

40. In 6½ fathoms, about 1¾ miles to the south of Ballantrae village. Net had dragged the bottom slightly. Several small stones, 1 *E. esculentus*, 2 *A. rubens*, and a few *O. fragilis* found in net near sole-rope, and in body; no deposited spawn. Fully 50 baskets of herring captured.

41. March 7th, 7.50 P.M. In 9½ fathoms. Net became fast for a time on the bottom and badly damaged. Two fronds of *Laminaria*, with stones 2½ to 3 inches attached to roots, taken from near sole-rope of net. No deposited spawn; net otherwise quite clean. 20 to 30 baskets of herring captured.

42. In 8 fathoms. Net had touched the bottom. One *Buccinum undatum* found in body of net; no deposited spawn. Fully 50 baskets of herring captured.

43. In 8½ fathoms. Net had dragged the bottom slightly. No deposited spawn found, and nets quite clean. 50 baskets of herring captured.

44. In 8 fathoms. Net became fast on bottom and was badly damaged, but quite clean. No fish captured.

45. In 9 fathoms. Net caught on bottom and was torn from sole-rope; quite clean. No fish captured.

46. In 8 fathoms. Net dragged slightly on bottom; taken up quite clean. 20 baskets of herring captured.

47. In 9 fathoms, near south edge of Bank. Net dragged on bottom a little. One stone 3½ inches and 1 dead *Pectunculus* shell taken from body of net; otherwise net quite clean. No deposited spawn observed.

48. In 9 fathoms. Net became fast for a little on bottom. Two stones 3¼ and 5¾ inches thinly coated with deposited herring spawn taken from near the sole-rope; otherwise net quite clean. A few herrings were captured.

49. In 8 fathoms. Net dragged the bottom slightly. Three fronds of *Laminaria* with stones at roots taken from near sole-rope, the fronds being thickly coated with herring spawn on the exposed surfaces, but none upon the stones at roots. A small quantity of deposited spawn with small stones was taken from the body of the net, also distinct traces of spawn found on sole-rope. About 15 baskets of herring were captured.

50. In 8 fathoms. Net touched the bottom, but came up quite clean. Five baskets of herring captured.

51. In 8½ fathoms. Net slightly dragged on bottom, but was found to be quite clean. Fully 100 baskets of herring captured.

52. In 7¾ fathoms. Net caught on bottom. Several fronds of *Laminaria* and 5 stones found in net near sole-rope; no deposited spawn. 40 baskets of herring captured.

53. In 9½ fathoms. Net dragged slightly on the bottom, becoming fast for a little. Two fronds of *Laminaria*, thickly coated with deposited herring spawn, taken from body of net; traces of deposited spawn observed also on body of net and sole-rope. A few baskets of herring captured.

54. In 7 fathoms. Net had touched the bottom. No deposited spawn found. About 3 baskets of herring captured.

55. In 8½ fathoms. Nets had touched the bottom, but found to be quite clean. Only a few herring captured.

56. In 7½ fathoms. Net became fast on the bottom, and was badly damaged, but came up quite clean. No deposited spawn, and only a few herrings captured.

57. In 7¾ fathoms. Net got fast on bottom and was badly torn. One *Laminaria* frond thickly coated with deposited spawn, with stones at roots, also thickly covered with spawn, and distinct traces of deposited spawn on sole-rope and body of net. Three baskets of herring captured.

58. In 7½ fathoms. Net became fast on bottom, and was badly torn. No deposited spawn found on net or sole-rope. No fish captured.

March 9th, 5.45 P.M.—Arrived on Ballantrae Bank among herring fleet; 48 boats counted.

59. In 8 fathoms, about 2 miles S.W. of Ballantrae village. Net dragged the bottom slightly. Three fronds of *Laminaria* with stones at roots, all thickly coated with deposited herring spawn; the sole-rope and body of net also showed distinct traces of deposited spawn. Only one spent herring was captured.

60. In 8 fathoms, a little to the N.E. of shot 59. Net dragged the bottom slightly; two fronds of *Laminaria* with stones at roots, all very heavily coated with deposited herring spawn on exposed surfaces, and a quantity of deposited spawn was found on the body of net. None observed on sole-rope. No fish of any kind captured.

61. In 8½ fathoms, near shot 60. Net had dragged the bottom slightly. One large frond of *Laminaria* heavily coated with deposited herring spawn, but none on stones at roots. Net otherwise quite clean. Fully 20 baskets of herring, mostly spent, and 3 saithe were captured.

62. In 8½ fathoms, about ¼ mile to the north of shot 61. Net caught on the bottom, and was brought up quite clean. One basket of spent herring captured.

63. In 8½ fathoms, near shot 62. Net caught on bottom, but came up quite clean. A few baskets of spent herring captured.

64. In 8½ fathoms. Net slightly dragged on the bottom. Three fronds of *Laminaria* with stones at roots, thickly coated with deposited herring spawn, taken from net near sole-rope; also one specimen of *Stenorhynchus*, with deposited spawn attached to the carapace and legs. One *Trochus* shell also coated with spawn; traces of spawn also observed on sole-rope and body of net. A few baskets of herring, mostly spent, were captured.

65. In 9 fathoms. Net fast on bottom, and got badly damaged. One frond of *Laminaria* with stones at roots, heavily coated with deposited herring spawn, taken from net near the sole-rope. One basket of herring, chiefly spent, captured.

66. In 8½ fathoms. Net caught slightly on bottom, but found to be quite clean. A few baskets of spent herring captured.

67. In 8¼ fathoms. Net dragged on the bottom slightly. One frond of *Laminaria* with stones at roots, all thickly coated with deposited

herring spawn, and traces of deposited spawn were observed on body of net and sole-rope. A few baskets of herring, chiefly spent, were captured.

68. In 7½ fathoms, near the north edge of Bank. Net dragged slightly on bottom. Two stones, 7½ inches and 5¾ inches, brought up, also a frond of *Laminaria*, which was heavily coated with deposited herring spawn. A few spent herring were captured.

69. In 8½ fathoms. Net slightly dragged on the bottom, becoming fast for a time. Four fronds of *Laminaria*, with stones at roots, very heavily coated with deposited herring spawn; the sole-rope and body of net also showed traces of deposited spawn. A few herring, chiefly spent, captured.

70. In 8 fathoms, near No. 69. Net slightly dragged on the bottom. One frond of *Laminaria* taken from near sole-rope and a fragment from body of net were thickly coated with spawn. 20 baskets of herring were captured.

71. In 8 fathoms, about 2½ miles S.W. of the village of Ballantrae, near edge of Bank. Several fronds of *Laminaria*, with stones at roots, thickly coated with deposited herring spawn, were taken from net near the sole-rope; a quantity of deposited spawn was also found on the sole-rope and about the body of the net. About 15 baskets of herring were captured, as well as 1 saithe of 31 inches and 1 cod of 6½ inches, both containing deposited herring spawn in their stomachs.

72. In 8½ fathoms, near N.E. edge of Bank. Net became fast on the bottom for a time, and was somewhat damaged. Five fronds of *Laminaria*, with stones at roots, heavily coated with deposited herring spawn; deposited spawn was also found on the sole-rope and the body of the net. No herring were captured.

73. In 9½ fathoms. Net slightly dragged on the bottom. Two fronds of *Laminaria*, with stones at roots, heavily coated with deposited herring spawn; small quantities of deposited spawn also taken from sole-rope and about the body of the net. Three baskets of herring, chiefly spent, were captured.

74. 10.35 P.M. In 9½ fathoms, as near as could be judged about the centre of the Bank, to the south of Ballantrae, towards the entrance to Loch Ryan. Net had dragged somewhat on bottom. 10 or 12 fronds of *Laminaria*, with stones at roots, 7 stones and rock fragments, a few *O. fragilis*, and 1 *E. esculentus* were taken from the net, but no deposited spawn was found. 20 to 30 baskets of spent herring were captured.

75. In 8½ fathoms, not far from shot 74, but a little farther north. Net had dragged on the bottom. Several fronds of *Laminaria*, with stones at roots, but no deposited spawn on either, and nets and sole-rope quite clean. No fish of any kind captured; net badly damaged.

76. In 8 fathoms. Net became fast on the bottom. Three fronds of *Laminaria*, with stones at roots, and several bottom-living animals. No deposited spawn found; net and sole-rope quite clean. A few spent herring captured.

77. In 8 fathoms. Net dragged the bottom slightly, and was badly damaged. No deposited spawn, net quite clean, and no fish captured.

78. In 9¼ fathoms. Net became fast on bottom, and was brought up damaged. Six stones and rock fragments, 2¾ to 9¼ inches, were taken from the net. No deposited spawn found; nets and sole-rope quite clean. No fish captured.

79. In 7½ fathoms. Several stones, 1¾ to 6½ inches, taken from the net, but no deposited spawn found. A few spent herring were captured. Net found to be perfectly clean.

Both the dredgings made by the "Garland" and the examination of the seine nets show that during last season large areas of the Bank were not utilised by the herrings as spawning ground. The deposited spawn was mostly got near and about the south and north-west edges, where *Laminaria* was abundant; the central region was practically devoid of spawn. In places where herring spawn exists it may be said that each haul of the seine net necessarily disturbs, and to some extent must destroy, some of it, as it lies on the bottom or attached to the fronds of the sea-weed, since the sole-rope sweeps over the bottom. But it is doubtful if the injury so caused is considerable or of much importance. The stones and weeds brought up by the net, whether coated with spawn or not, are thrown back into the sea by the fishermen. The destruction of herring eggs in this way cannot be great, and it is certainly quite insignificant compared with the depredations of predacious fishes, or the loss of eggs involved by the capture of large numbers of herrings in the act of spawning. At the spawing season at Ballantrae Bank not only are the herrings themselves preyed upon in enormous numbers by cod, saithe, ling, dog-fish, cetaceans, gannets, and other enemies, but their freshly-deposited spawn is also devoured in immense quantities, especially by haddocks, codling, and saithe, as well as by their own species. Haddocks are sometimes taken in large numbers in the seine nets at Ballantrae, and I found their stomachs to be full of herring spawn, frequently mixed with fine gravel, while as much as 1 lb., and even 24 ounces, of spawn has been taken from the stomach of a single cod.* The destruction of spawn in this way by enemies must, however, be regarded as a normal condition in the life-history of the herring. But there is also an immense loss in the fishing operations. The majority of the herrings taken are captured in the act of spawning, with the ripe eggs and milt running from them, and when a large catch is obtained the quantity of spawn and milt that is emitted in the handling of the fish is very great, and gives the herrings a very unsightly appearance. The boats, nets, and gear, and everything that comes in contact with the mass of fish becomes coated with spawn; the parts of the quay at which they are landed from the boats may be covered with a layer of spawn half an inch or more in thickness; and the spawn thus accumulated and discharged in the selection and handling of the fish may form considerable ill-smelling heaps. It was this loss of spawn, as well as the capture and disturbance of the spawning shoals, that led to the close-time by which the winter fishing at Ballantrae was put down; and it caused the Board of British White Herring Fishery many years before that to strongly urge the complete suppression of the fishery.

The destruction of deposited spawn, and the loss of eggs in the way described, is not peculiar to the seine net. The trammel net must also cause disturbance and loss of deposited spawn while being hauled and set. All the appendages of the net may be coated with fertilised spawn—the sole-rope, the stones used as anchors, and the meshes. So abundant is the deposition that frequently boats anchoring on the Banks, as the seine boats, bring up their anchors whitened with the deposition of eggs; this occurred also with the anchor of the "Garland." The trammels also cause loss of unfertilised spawn, although not as a rule to the same extent as the seine, because the herrings may remain a

* The contents of some of the stomachs were weighed and the number of herring eggs calculated. A haddock of between 2 lbs. and 3 lbs. in weight was found to contain more than two ounces of spawn, or nearly the whole of the eggs produced by two adult herrings. In February of 1890 nine tons of haddocks were taken from Ballantrae Bank, which would be equivalent to about 7000 individuals; and if each of these consumed daily a similar quantity of herring spawn as the one referred to, the spawn of over 300,000 herrings, or about 9,000,000,000 eggs, would be destroyed by that number alone in the course of the month or six weeks involved.

considerable time in the net before it is hauled, and a proportion of the eggs are discharged and no doubt fertilised. There is not so much spawn intermingled with the fish in the catches from the trammel boats as there is from the seine boats.

To what extent the loss of spawn at Ballantrae Bank or the disturbance of the shoals may have proved detrimental to the permanence of the fishery from season to season, it is not easy to decide. If it could be clearly shown that this spawning ground for the herring was in close relationship to important herring fisheries at other parts of the coast, as in Loch Fyne, and that the fishery there exercised an injurious effect on the more important fisheries, there might be reasonable grounds for interference on this score. But the evidence on either point is not convincing. It is generally agreed that the large herrings which are known to leave Loch Fyne towards the close of the season do not spawn at Ballantrae Bank. On the other hand, it is very widely held that the mixed and smaller class of herrings that leave Loch Fyne in many seasons pass over to the northern part of the coast of Ayrshire, give rise to the winter fishing there, and then pass on to Ballantrae Bank; and that after spawning the herrings return to Loch Fyne by way of the Sound of Kilbrennan. But in some seasons the bulk of the herrings from Loch Fyne pass down by the Sound of Kilbrennan, and the relation of these movements to the Ballantrae fishing is not clear. On the other hand, the herring shoals are sometimes first found coming to Ballantrae from the south by way of Loch Ryan, and it is quite possible that they may come from off the Irish coast, which is considerably nearer than is Loch Fyne. Experiments on the point were made by marking and then liberating many hundreds of herrings, both at Ballantrae and in Loch Fyne and the Sound of Kilbrennan, but only two of the marked fish are known to have been recovered, and they throw no light on the problem.

Conclusion.

With regard to the destructive action of the seine net in the capture of immature herrings, there is no doubt that this net from its mode of working may take considerable quantities of small herrings that would escape capture by the drift net or the trammel net, and in this respect the seine net might be regarded as destructive. But there is no evidence to show that its action is wasteful or injurious to the permanence of the supply of herrings in Loch Fyne. The contrary is indicated by the statistics of the fishery, which prove that, while the use of the seine net has increased, the supply has not only not diminished but has been augmented. The capture of immature fish is incidental to all modes of fishing, whether by net, line, or trawl. There is no fishery in which the fluctuations are more marked than in the herring fishery; there is none pursued so extensively, and yet the permanence of the supply over a period has been well established.

With regard to the winter fishery at Ballantrae Bank, the conditions are very different from what they are in Loch Fyne. The area of the Bank proper is limited; the water is comparatively shallow, and the bulk of the herrings are captured while spawning. In Loch Fyne the water is deep, and the fishing operations, unless when conducted close to the shore, are confined to the stratum near the surface, and the fishery is not for spawning fish. The seine net, when used at Ballantrae Bank, extends from the surface to the bottom and encloses everything that comes within its reach, and there is little doubt that it is in the power of seine-net fishermen to sweep this limited area almost clean of herrings

for the time. The destruction of deposited spawn does not appear to be of much importance, but an excessive fishing on the Bank among the spawning shoals and constant sweeping of the bottom is not unlikely to prove injurious. The extent of the spawning ground off Ballantrae is not great. Even with the 70 boats which were sometimes fishing there during the season just passed the area appeared to be considerably crowded, and it is not surprising that damage occurs to the set nets as alleged by the trammel fishermen. There are reasons to believe that the prohibition of the use of the seine net during a part of February and March in each year might prove beneficial to the herring fishery in future seasons, and would not cause much, if any, hardship to the seiners. Their nets can still reach the bottom in the somewhat deeper water outside, beyond the actual spawning ground, where abundant catches are frequently obtained. The following boundaries would include the area in question, viz., a straight line passing seawards in a N.W. direction for three geographical miles from Bennan Head; a similar line passing for the same distance from Downan Point; and a line, parallel with the shore, between the extremities of the above lines.

VI.—THE FISHES OF THE FIRTH OF CLYDE.

By Thomas Scott, F.L.S., Mem. Soc. Zool. de France.

It has been considered desirable that a list should be prepared of the fishes which have from time to time been observed within the limits of the Clyde estuary. The list is not a descriptive one, but is merely an enumeration of the various species which have come under the notice of the writer, together with those which have been recorded by different authors who have written on the fauna of the Clyde, or which have been seen by persons whose accuracy may be relied on. The following are the chief sources from which my information concerning Clyde fishes has been obtained:—

(1.) A List of Loch Fyne Fishes, prepared for the most part by the late George Brook, Esq., F.L.S., and published in the *Fourth Annual Report of the Fishery Board for Scotland* (1886). (A Revised List of Loch Fyne Fishes is published in the Board's *Fifteenth Annual Report*, Part III., 1897).*

(2.) A paper by Dr. Albert C. L. G. Günther, F.R.S., entitled, "Report on the Fishes obtained by Mr. (now Sir) J. Murray in deep water on the North-West Coast of Scotland, between April 1887 and February 1888," published in the Proceedings of the Royal Society, Edinburgh, Vol. XV. (1888). In this report 31 species are recorded, one of which was new to science, while two were additions to the British fauna. The species recorded in Dr. Günther's paper were mostly from the Clyde area, and there are some interesting notes on the bathymetrical distribution of the species.

(3.) *A Vertebrate Fauna of Argyle and the Inner Hebrides*, by J. A. Harvey-Brown and Thomas E. Buckley, published in 1892. The part of this work which is referred to in the present paper is the separate reprint of the list of fishes. In the list of fishes given in this work, the authors include Dr. Günther's records mentioned above, in the form of foot-notes under each of the species to which the records specially refer; additional Clyde records are also given in this work.

(4.) The statistics published in the *Annual Reports of the Fishery Board for Scotland*, in so far as they relate to the fishes of the Firth of Clyde, and especially to those fishes which have been captured by the Fishery steamer "Garland."

I have also to acknowledge my indebtedness to Mr. Duthie, the Fishery Officer at Girvan, and to Mr. Gray of the Marine Station, Millport, Cumbrae, for interesting information relating to Clyde fishes. Other sources of information are duly acknowledged in the sequel.

Before proceeding with the enumeration of species, it may be of interest to refer to some points concerning the distribution of one or two of the forms which are usually considered to be more or less rare in the Clyde area. Previous to the investigations carried on by Dr. (now Sir) John Murray, by means of the s.s. "Medusa," the fish usually called the Sharp-tailed Lumpenus, *Lumpenus lampetræformis*, was not known to occur within the limits of the Clyde; but now, by the use of a small-mesh trawl-net, this fish is found to be comparatively frequent

* The compiler of this revised list had the privilege of consulting the records of Loch Fyne fauna obtained by the s.s. "Medusa" as the result of the investigations carried on by Sir John Murray on the West Coast.

and more or less generally distributed, especially in the deep-water area. The same may be said of the Argentine, *Argentina sphyræna*. This fish, which used to be considered a rare species in the Clyde, is really not very uncommon when sought for with suitable appliances. It may be pointed out further that if anyone were to look through the lists of Clyde fishes captured by the "Garland," he would fail to find a single record of a Halibut, which is only occasionally taken by a trawl. Moreover, the halibut is not mentioned for the Clyde in Dr. Günther's paper, nor in the work published by Harvey-Brown and T. E. Buckley already cited, yet the Fishery Officer at Girvan informs me that halibut are not very rare in the seaward part of the Clyde estuary, and that they are sometimes caught in the deep water off Ayr; while in a letter, dated the 28th December last, he states that he had seen, a few days before, a young halibut landed at Girvan, which had been caught between that place and Ailsa Craig, and which weighed about a stone.

In looking through the statistics of the steamer "Garland," it will also have been observed that Turbot and Brill are not very frequently mentioned in the lists of fishes captured by the steamer in the Clyde estuary, yet there is a more or less regular turbot fishery carried on off Girvan, and sometimes a considerable number of these fishes, captured in the Clyde by gill-nets, are brought to market. It is obvious from facts such as these that, though one mode of fishing may yield negative results in respect of certain species, it does not necessarily follow that these species are absent or even rare. The results obtained by the use of the ordinary beam or otter trawl are usually very different from those obtained by the use of special nets or lines, therefore a kind of fish that may be seldom or never captured by one set of appliances, may by the use of a different set be found comparatively frequent.

The present enumeration comprises 113 species of Clyde fishes, but the occurrence of one or two of these appears to be somewhat doubtful; and it is also very desirable in the case of one or two others which, though their presence in the Clyde seems to be fairly well attested, further information should be obtained concerning them. I have indicated such species by enclosing their names within square brackets, and also by the notes referring to them.

There are several kinds of fishes which appear to be equally at home in the sea and in brackish water, and in some cases even in water that is fresh or nearly so; and there is a considerable divergence of opinion as to which, and how many, of these should be included in lists of *marine* species, and of those which should more properly be regarded as *fresh-water* forms. One has only to compare Professor H. G. Seeley's interesting work on *The Fresh-Water Fishes of Europe* with that of *The British Marine Food-Fishes*, by Professor M'Intosh and Mr. A. T. Masterman, to find examples of this difference of opinion. In the present list there will probably be found species which, in the opinion of some people, should have been excluded as belonging more properly to the fresh-water group; but when we find distinguished writers failing to agree on such a point as this, I may be excused if unable to prepare a list perfect in this respect. The basis of this list is the enumeration of Loch Fyne fishes, already referred to, prepared by the late George Brook, Esq., and published in 1886.

I have followed as far as possible the nomenclature used by Professor M'Intosh and Masterman in their *British Marine Food-Fishes*, while the arrangement of the species is in accordance with that of the *History of British Fishes* by Dr. Francis Day.

The following abbreviations are also used :—

(B. & S.) Refers to the list of Loch Fyne fishes published in the *Fourth Annual Report of the Fishery Board for Scotland.*
(Günther) Refers to Dr. Günther's paper published in the Proceedings of the Royal Society, Edinburgh, 1888, Vol. XV., pp. 205-220.
(H.B.) Refers to the separate reprint of the List of Fishes published in Harvey-Brown and Buckley's work on the Vertebrate Fauna of Argyle and the Inner Hebrides.
(G.) Refers to the "Garland's" statistics.
(M.) Refers to MS. records for Loch Fyne of the s.s. "Medusa," showing some of the records obtained by Sir John Murray while investigating the marine fauna and flora of the West Coast.

SUB-CLASS TELEOSTEI.

Order ACANTHOPTERYGII.

Fam. PERCIDÆ.

Polyprion americanus (Bl. Schneider). The Stone Basse.

This is the *Polyprion cernium* of Day's *British Fishes.* "One was taken years ago at the mouth of the Clyde" (Aflalo). "It was also taken off Little Cumbrae in 1870 by Dr. J. Young" (H.B. p. 184). The Stone Basse appears to be only an occasional visitor to the Clyde, for although it is included in the *Vertebrate Fauna of Argyle and the Inner Hebrides* the above is the only locality for the species given by the authors.

Fam. MULLIDÆ, Swainson.

Mullus barbatus, Linné. Surmullet, Red Mullet.

Loch Fyne (Captain Campbell of Inverneil). Captain Campbell in referring to this species says:—"I caught one in Loch Fyne . . . in a trammel net in 10 fathoms, and though I tried in many places for them I never got another" (*see* H.B., p. 185).

Fam. SPARIDÆ, Cuvier.

Pagellus centrodontus (De la Roche). The Common Sea Bream.

One specimen of *Pagellus centrodontus* was taken by Mr. M. P. Bell at Cumbrae, on July 12th, 1885 (*see* Robertson in Proc. N.H.S. Glasgow, Vol. I., p. 119). When at Tarbert in 1885–86, I remember seeing a specimen which was washed ashore in East Loch Tarbert, and which appeared to have been but a short time dead. It was probably captured in the nets of the herring boats fishing in the vicinity of East Tarbert and having been thrown back into the sea had drifted ashore. In the *Vertebrate Fauna of Argyle and the Inner Hebrides, Pagellus centrodontus* is described as "locally numerous throughout the West of Scotland." The species is sometimes brought in in large numbers to the fish market at Aberdeen.

Fam. COTTIDÆ.

Cottus scorpius, Linné. The Sea Scorpion.

Cottus scorpius is generally distributed throughout the Clyde and Loch Fyne, but it seems to be more frequent inshore than in deep water. "Two immature specimens were taken between Cloch Lighthouse and

Whiting Bay in 15 to 30 fathoms in July, and one immature specimen between French and Kilbrennan Sound in 10 to 14 fathoms in March" (Günther). The variety *grœlandicus* is also occasionally obtained in Loch Fyne; a specimen of the variety in the Fishery Board's collection at Bay of Nigg measures slightly over one foot in length. Dr. Day remarks that the sea scorpion is said to attain to six feet in length in the Greenland seas, while the largest recorded example in Great Britain is fifteen inches.

Cottus bubalis, Euphrasén. The Father Lasher.

Moderately common in Loch Fyne (B. & S., 1886). "A very young specimen was obtained at the Mull of Cantyre in 60 fathoms in February, and another immature one in the Sound of Sanda in 20 fathoms in March, 1885" (Günther). Little Harbour, Upper Loch Fyne, December 1896. Off Inveraray, 1897. Young specimens are moderately frequent amongst seaweed in the shallow inshore bays of Loch Fyne.

Cottus lilljeborgii, Collett. The Norway Bullhead.

"Off Ardrossan, 15 to 30 fathoms; Sound of Sanda, 20 fathoms" (Günther). This is one of the species added to the British fauna by Dr. (now Sir) John Murray. It seems to be a small species. The specimen caught off Ardrossan measured 2½ inches in length, while that from the Sound of Sanda was only 1¾ inches long.

Trigla lineata, Gmelin. The Streaked Gurnard.

East Loch Tarbert, Loch Fyne, not common (B. & S.). One was obtained in the trawl of the s.s. "Garland" at trawling Station VI.* (near the mouth of the Clyde) on November 25th, 1895. Two were captured at trawling Station XI. on April 21st, 1897, and another at Station VIII. in September of the same year. Mr. Pearcey records that five were caught last year (1899) at Stations I., VI., VII., and IX. Dr. Day refers to one specimen of *T. lineata* having been procured near Ayr, and a second in October 1844 at Glasgow.† It appears to be a rare species in the Clyde.

Trigla cuculus, Linné. The Red Gurnard.

Red Gurnards are occasionally captured by the "Garland" in the seaward part of the Clyde estuary, but do not seem to be very common. They appear to have been more frequently recorded from the Clyde last year (where the "Garland" was chiefly employed) than for some years previously. In looking over the returns of the "Garland" for 1899, it is interesting to observe that while these fishes were captured in every haul made at Station VI., at Station VIII. they occurred in three of the hauls, and in only two of the hauls made at each of the Stations I., VII., IX., and X. At Stations III. and XII. they were only once captured, and none are recorded from any of the hauls made at Stations II., IV., V., and XI.

Ninety hauls were made by the "Garland" last year at Stations I. to XII., and Red Gurnards were obtained in twenty-one of them; the number of specimens recorded from these twenty-one hauls is 73, and the number obtained in each haul may be summarised as follows:—

* The situation of the Stations is described on p. 20 of this Report.

† *British Fishes*, Vol. I., p. 58.

7	hauls	contained	1	Red	Gurnard	each =	7.
3	„	„	2	Red	Gurnards	each =	6.
3	„	„	3	„	„	=	9.
3	„	„	4	„	„	=	12.
1	„	„	5	„	„	=	5.
1	„	„	7	„	„	=	7.
2	„	„	8	„	„	=	16.
1	„	„	11	„	„	=	11.
21							73

Fifteen specimens of Red Gurnards were obtained in one haul at Station VIII. in December 1898, but such a large number in one haul is exceptional. They are also recorded by Landsborough in his *Natural History of Arran*, p. 492.

Trigla lucerna, Linné. The Sapphirine Gurnard.

This, which is the *Trigla hirundo* of Day's *British Fishes*, appears also to be moderately rare in the Clyde. Thompson remarks that he has seen this species in autumn captured in salmon nets at Ballantrae, in Ayrshire, and on different parts of the coast in the country (Day).* I do not find it recorded amongst the captures of Clyde fishes made by the Fishery steamer "Garland."

Trigla gurnardus, Linné. The Grey Gurnard.

Common, and generally distributed throughout the seaward part of the Clyde and in Loch Fyne, especially during the summer months. This seems to be a common species throughout the Scottish seas. Large quantities of gurnards are sometimes landed at the fish market at Aberdeen, and they nearly all belong to this species.

Triglops murrayi, Günther. Murray's *Triglops*.

"Several specimens from 2½ to 4 inches long were obtained at the Mull of Cantyre at a depth of 64 fathoms in the months of February and March, and 4 miles south-east of the Island of Sanda in 35 fathoms in the middle of March 1887" (Günther). One specimen 2½ inches long was captured in the shrimp-trawl of the "Garland," in the vicinity of Sanda, November 1896. *Triglops murrayi* is described as closely allied to *Trigla pengellii*; it is one of the species added to the British fauna by Dr. (now Sir) John Murray.

Fam. Cataphracti, Müller.

Agonus cataphractus, Linné. The Pogge.

Ardrishaig (Dr. Scouler). Occasionally in other parts of Loch Fyne and the Clyde estuary. "Five specimens from the Mull of Cantyre, 49 to 50 fathoms, February. Two specimens from Kilbrennan Sound, 10 to 20 fathoms, March 1888" (Günther). It has also been got by the "Garland" at Stations I. and VI.

Fam. Pediculati, Cuvier.

Lophius piscatorius, Linné. The Angler.

The Angler is frequently taken in the trawl-net of the Fishery steamer "Garland," and especially at those stations where the water is

* *British Fishes*, Vol. I., p. 62.

moderately deep. One or more are got in most hauls of the trawl at all the Stations, except in Loch Fyne, where it is much less common. No specimens have been caught at Stations XV. or XVII.; one was taken at Station XVI. in over 60 fathoms. The largest obtained was 49 inches (Station I., 30th May 1899). *Lophius* is sometimes obtained larger than any of the Clyde specimens; in December 1841 Thompson examined one that was four and a half feet in length.*

Fam. TRACHINIDÆ, Risso.

Trachinus vipera, Cuvier. The Lesser Weaver.

Recorded from Arran by Dr. Landsborough in his *Natural History of Arran*, p. 318. He states that the lesser weaver is known to the people at Lamlash as the "Stangster" or "Stang-fish."

Fam. SCOMBRIDÆ, Cuvier.

Scomber scombrus, Linné. The Mackerel.

Shoals of mackerel are occasionally observed both in the Clyde estuary and in Loch Fyne, and considerably over a thousand cwts. are usually landed by fishermen each year. Dr. Day, though he gives a very full description of the habits, habitats, etc., of the mackerel, makes no allusion to its occurrence in the Clyde or Loch Fyne, neither is any notice taken of its occurrence in these places in the *Vertebrate Fauna of Argyle and the Inner Hebrides.*

Orcynus thynnus, Linné. The Tunny.

Pennant records a specimen weighing 460 lbs. taken at Inveraray in 1769. An example, 9 feet long, was captured in the Gareloch, nearly opposite Greenock, in July 1831.† This last specimen is said to have been in pursuit of herrings.

Thynnus pelamys, Linné. The Bonito.

One was captured in the Clyde in July 1832,‡ and purchased for the Andersonian Institute of Glasgow.§ Jenyns is doubtful if the fish recorded by Dr. Scouler is the true *Thynnus pelamys*, but suggests that it is more likely to be the next one.

Pelamys sarda, Bloch. The Belted Bonito.

One was captured in the Clyde in 1859, and is now in the Hunterian Museum, Glasgow.

Fam. CORYPHÆNIDÆ (part), Swainson.

Brama raii, Bloch. Ray's Bream.

One specimen in the Hunterian Museum was taken near Ayr (H.B., p. 188).

Lampris luna, Gmelin. The Opah or King Fish.

One was taken in the Clyde in 1833 (Scouler). A specimen of the king-fish in the Hunterian Museum, Glasgow, was captured in the Clyde in 1864.

* Day, *British Fishes*, Vol. I., p. 76.
† Day, *British Fishes*, Vol. I., p. 97.
‡ Scouler, *Mag. Nat. History*, Vol. VI., p. 529 (1833).
§ Day, *British Fishes*, Vol. I., p. 101.

Fam. CYTTIDÆ, Kaup.

Zeus faber, Linné. The John Dory.

The John Dory has been taken off Rothesay (H.B., p. 186); in Loch Fyne (B. & S.); in Kilbrennan Sound in the shrimp-trawl of the Fishery steamer "Garland," and in other parts of the Clyde estuary (Stations I., II., III., VI., and VII.), but most of the Clyde specimens I have seen are small and immature. Those taken by the "Garland" usually range from 10 to 14 inches; the largest was 19 inches and the smallest three inches.

Fam. GOBIIDÆ, Cuvier.

Gobius flavescens, Fabricius. The Two-Spotted Goby.

Loch Fyne (Dr. Scouler); common amongst *Zostera* in East Loch Tarbert (B. & S.); Upper Loch Fyne (M.); also in various parts of the Clyde estuary (G.). Though *Gobius flavescens* is widely distributed throughout the Clyde area it does not appear to be very common. This is the *Gobius ruthensparri* of Day's *British Fishes*.

Gobius niger, Linné. The Black Goby.

Taken in the Clyde area (H.B., p. 193). Moderately common, especially off shore; but most of the specimens captured by the "Garland" are of comparatively small size, few of them reaching a length of four inches.

Gobius minutus, Gmelin. The Spotted or Speckled Goby.

Common, and generally distributed throughout the estuary, including Loch Fyne and the other sea-lochs within the Clyde area. Günther records *Gobius minutus* from Loch Goil in 45 fathoms, and in the vicinity of Cloch Lighthouse in 43 fathoms. It has also been taken by the "Garland" at the head of Upper Loch Fyne in from 17 to 35 fathoms.

Gobius jeffreysii, Günther. Jeffrey's Goby.

"Three specimens were obtained in April, viz., in Lamlash Bay (6 to 18 fathoms), off Whiting Bay (20 fathoms), and off Cumbrae Light (56 fathoms). Five specimens in August off the Cloch Lighthouse in 43 fathoms. Two adult specimens, male and female, obtained in Kilbrennan Sound at an uncertain depth (10 to 45 fathoms) on March 22nd, 1888" (Günther). This species has not yet been obtained by the Fishery steamer "Garland."

Several of the species of *Gobius* are somewhat difficult to make out, and it is just possible that other species in addition to those named may also occur in the Clyde.

Fam. CALLIONYMIDÆ, Richardson.

Callionymus lyra, Linné. The Dragonet or Gemmeous Dragonet.

The dragonet is not uncommon in the Clyde and Loch Fyne; it is frequently mentioned amongst the captures of fishes made by the Fishery steamer "Garland," and especially amongst the fishes taken with the shrimp-trawl. As many as 47 specimens were recorded from one haul made on November 11th, 1896, and Mr. Pearcey records 125 specimens captured in a single haul on September 5th 1897, between Cantyre and Ailsa Craig.

Callionymus maculatus (Bonaparte). The Spotted Dragonet.

Kilbrennan Sound, rather abundant at 26 fathoms; Sound of Sanda, 24 to 28 fathoms (H.B., p. 194). Occasionally captured in the shrimp-trawl of the Fishery steamer "Garland."

Fam. DISCOBOLI, Cuvier.

Cyclopterus lumpus, Linné. The Lumpsucker or Cock-Paidle.

The lumpsucker is occasionally captured in the Clyde by the "Garland." Young specimens are sometimes observed in the tow-net gatherings collected in Loch Fyne as well as in other parts of the Clyde estuary. Thompson mentions its existence in the vicinity of Ayrshire.*

Cyclogaster liparis, Fleming. The Sea Snail or Sucker.

The sucker is not uncommon in Loch Fyne, and also in the Clyde, but usually inshore where the water is shallow and the bottom weedy. It is, however, recorded from water that is also of considerable depth. Dr. Günther in his report to the Royal Society of Edinburgh† records many specimens from 49 and 64 fathoms in the vicinity of the Mull of Cantyre, and three specimens from 30 to 40 fathoms between Cumbrae and Wemyss Point. It has been got by the "Garland" in 66 fathoms, 8 miles W. by N. of Corsewall Point, and in the same depth S.E. of the Mull of Cantyre.

Cyclogaster montagui, Donovan. Montagu's Sucker.

Not so common as the last, but the habitat is somewhat similar.

Fam. GOBIESOCIDÆ, Bleeker.

Lepadogaster gouanii (Lacep.). The Cornish Sucker.

This species has been taken at Millport (H.B., p. 198). I have not yet seen a Clyde specimen of *Lepadogaster gouanii*; but probably it may not be very rare if sought for in the right places.

Lepadogaster bimaculatus (Cuvier). The Doubly-spotted Sucker.

Recorded by Dr. Landsborough from Lamlash Bay, Arran. He describes it as "far from being rare."‡ Taken in the Clyde area (H.B.).

Anarrhichas lupus, Linné. The Wolf Fish, Cat fish.

Not uncommon amongst the captures of fishes made by the s.s. "Garland," both in the Clyde and Loch Fyne.

Fam. BLENNIIDÆ, Swainson.

Blennius pholis, Linné. The Shanny.

In Clyde area (H.B., p. 185). Mr. Alex. Gray, of the Marine Station, Millport, Cumbrae, in a note dated December 11th, 1899, says:—"Last spring I caught a specimen of *Blennius pholis* here, and kept it alive for about four months. Unfortunately it managed somehow to jump out of the tank, and in the morning I found it on the floor, dead. It is now in our collection, preserved in formaline."

* Day, *British Fishes*, Vol. I., p. 182.

† Proc. Vol. XV., p. 41.

‡ *Natural History of Arran* (1875), p. 328.

Chirolophis galerita, Linné. Yarrell's Blenny.

One specimen was taken amongst boulders at low water in East Loch Tarbert in 1885 (B. & S.). Ballantrae Bank, one specimen in January 1899 (G.).

Pholis gunnellus, Linné. The Gunnel or Butter-fish.

The butter-fish is common and generally distributed, and especially inshore amongst weed and stones, where it may frequently be found when the tide recedes.

Euchelyopus (*Zoarces*) *viviparus*, Linné. The Viviparous Blenny.

A specimen of this species, captured in the vicinity of Row, near Helensburgh, is in the collection of the late Dr. Robertson of Millport at the Marine Station there. I am indebted to Mr. Gray, the Curator, for this record.

In the *Vertebrate Fauna of Argyle and the Inner Hebrides*, the viviparous blenny is recorded from Loch Creran, the Sound of Jura, and from Glenshiel, "but it seems to be rare on the West Coast." There is no Clyde record for the species in this work.

Lumpenus lampetraeformis (Walbaum). The Sharp-tailed Lumpenus.

"Three adult specimens were found between Cumbrae and Skelmorlie Lighthouse in 20 fathoms in April 1887, and at Cumbrae Lighthouse in 60 fathoms in February 1888" (Günther). Occasionally captured off shore in the shrimp trawl-net of the Fishery steamer "Garland." As many as a dozen specimens of this rare species have been taken at one time by the Fishery steamer in the lower part of the Clyde estuary, whilst in 1896 four specimens were captured near the head of Upper Loch Fyne.

It requires a net with moderately close meshes to capture this species—an ordinary trawl-net is usually ineffective.

In a work on British Natural History published in 1898, the author, F. G. Aflalo, has the following note within square brackets at p. 371:—"The sharp-tailed lumpenus was once trawled (1884) off the Carr Light-ship," and he adds that he gives this record "on the authority of M'Intosh and Masterman"; evidently he was unaware of Dr. Günther's records for the Clyde, and the Fishery Board's for the Firth of Forth.

Fam. CEPOLIDÆ, Bleeker.

Cepola rubescens, Linné. The Red Band Fish.

One 15½ inches long was taken on a whiting line 7 miles south of Ayr (Harvey). Another 19½ inches long was found on the beach at Ballantrae after a storm (Thompson). "Two have been taken on the Ayrshire coast just inside the Clyde area" (H.B., p. 195). Perhaps this last record refers to the same specimens mentioned by Harvey and Thompson.

Fam. ATHERINIDÆ, Günther.

Atherina presbyter, Cuvier. The Sand Smelt or Atherine.

Frequent amongst zostera in East Loch Tarbert in the spring of 1885, but not met with later (B. & S.). Mr. Gray, of the Millport Marine Station, states:—"On two occasions I saw shoals of these little fishes in Campbeltown Loch—once at the Kilbrennan shore, where they were pursued by a number of guillemots, which chased them so keenly that

they jumped clean up on the gravelly beach, and I collected quite a number of living specimens. Many of the fishes were fully two feet from the water's edge."

Fam. MUGILIDÆ.

Mugil capito, Cuvier. The Grey Mullet.

The "ear-stones" (*otolites*) of a grey mullet (*Mugil capito*, Cuv.), captured in the Clyde off Fairlie, are in the collection of the late Dr. Robertson of Millport, at the Marine Station there. I am indebted to Mr. Gray, the Curator, for this record.

In the *Vertebrate Fauna of Argyle and the Inner Hebrides*, *Mugil capito* is recorded from several localities on the West Coast of Scotland, but there is no record of it from the Clyde.

Fam. GASTEROSTEIDÆ.

Gasterosteus aculeatus, Linné. The Three-spined Stickleback.

Captured occasionally with the push-net at various parts of the shores of Loch Fyne; we have it also from other parts of the Clyde estuary.

Gasterosteus spinachia, Linné. The Fifteen-spined Stickleback.

The fifteen-spined stickleback is more or less common amongst sea-weed in shallow water; it is generally distributed along the shore line, both of the Clyde estuary and the lochs branching from it.

Fam. LABRIDÆ, Cuvier.

Labrus bergylta, Ascanius. The Ballan Wrasse.

The Ayrshire and Wigtown coasts (Thompson). In the Clyde area (Dr. J. Young, *vide* H.B., p. 199). Frequent in Loch Fyne in the autumn (B. & S.).

Labrus mixtus, Linné. The Striped Wrasse.

Taken occasionally at the mouth of East Loch Tarbert, Loch Fyne (B. & S.). It is also recorded in Harvey-Brown's *Vertebrate Fauna of Argyle and the Inner Hebrides*, and on the authority of Dr. J. Young as occurring in the Clyde area.

A male and a female of this species were captured in Ayr Bay by a fisherman on January 30th this year (1900); the specimens were secured by Mr. Duthie, Fishery Officer, Girvan, who happened to be in Ayr at the time, and were forwarded by him to the Laboratory at Bay of Nigg.

Crenilabrus melops, Linné. The Goldsinny or Corkwing.

A small specimen of the goldsinny was captured by the "Garland" near Cairndow, at the head of the Loch Fyne, in August 1899. One specimen from Lamlash Bay in 6 to 18 fathoms, April (Günther).

Ctenolabrus rupestris, Linné. Jago's Goldsinny.

Common, especially near Skate Island, Loch Fyne (B. & S.). Occasionally obtained in the trawl-net of the Fishery steamer "Garland." One specimen was obtained in Lamlash Bay in 6 to 18 fathoms, in April, and another between Cumbrae and Skelmorlie Buoy in 20 fathoms, in the same month, 1887 (Günther).

Centrolabrus exoletus, Linné. Small-mouthed Wrasse, Rock Cook.

Taken occasionally in Loch Fyne (B. & S.).

Coris julis (Linné). The Rainbow Wrasse.

Recorded for the Clyde area on the authority of Dr. J. Young (H.B., p. 200).

Order ANACANTHINI.

Fam. GADIDÆ, Cuvier.

Gadus callarius, Linné. The Cod.

Common and generally distributed. The natural habitat of the cod is in moderately deep water; this is shown by the fact that if they are exposed for a lengthened period to daylight their eyes become more or less diseased. When at Rothesay Aquarium in 1886–87 I observed that the eyes of almost all the specimens of cod kept there were diseased, and one specimen was entirely blind and had to be fed separately. This disease, which at first took the form of an opaque white spot, but which gradually extended all over the eye, was ascribed to the fish being kept exposed to the daylight. The cod were the only fishes in the Aquarium that were affected in this way.

Gadus æglefinus, Linné. The Haddock.

More or less frequent, and generally distributed throughout the Clyde area, but much less abundant than on the East Coast. Upper Loch Fyne in the centre in 65 to 70 fathoms (M.); between Pennymore and Inveraray (G.).

Gadus luscus, Linné. The Bib, or Whiting Pout.

Occasionally in Tarbert harbour (B. & S.); Tarbert Bank, Lower Loch Fyne; and between Dunderawe and Cairndow, Upper Loch Fyne (G.). Generally distributed throughout the Clyde estuary, but seldom more than 8 to 10 inches in length. Two, 13 inches in length, were obtained near Sanda Island in May 1897. A specimen in the Fishery Board's collection in the Laboratory at Bay of Nigg measures fully 15 inches in length.

Gadus minutus, Linné. The Poor or Power Cod.

Dr. Günther in his paper on Clyde Fishes states that "the specimens obtained on March 10th and 17th were ready to spawn, and had fed on *Nyctiphanes*, sand eels, and *Aphrodite*." This *Gadus* is usually more or less in evidence amongst the contents of the shrimp-trawl of the Fishery steamer "Garland."

Gadus esmarkii (Nilsson). The Norway Pout.

According to Dr. Günther, the distribution of this species in the Clyde extends from Kilbrennan Sound to Lower Loch Fyne, where young specimens were found in tolerable abundance at 80 fathoms. He also remarks that "the species does not appear to be unfrequent in Kilbrennan Sound." He states further that "the characteristics by which *Gadus esmarkii* can be distinguished from its British congeners are:—The lower jaw, which projects beyond the upper; the dentition, the teeth of the outer series in the upper jaw being a little larger than the inner ones; the

length of the snout, which is almost equal to the length of the diameter of the eye, which is a little less than one-third the length of the head; the slender barbel, which is about half as long as the eye; and, finally the fin formula—it being D 15–16, 23–25, 22–25; A 27–29, 23–25" (H.B., p. 203). *Gadus esmarkii* is, in some respects, not unlike *Gadus minutus*, and may have occasionally been mistaken for that species. It is occasionally taken in the shrimp trawl-net of the "Garland."

Gadus merlangus, Linné. The Whiting.

This is one of the more common and generally distributed of the *Gadi*; but though extending into Upper Loch Fyne it is described as "not abundant" there. The whiting appears to be more frequent in the seaward portion of the Clyde estuary than it is in the more inland parts.

Gadus poutassou, Risso. Couch's Whiting.

This is readily distinguished from other British *Gadi* by the position of the dorsal fins, and especially by the distance between the second and third dorsals being greater than the distance between the same fins in the whiting, which it somewhat resembles. Three specimens of *Gadus poutassou* were captured in the shrimp-trawl of the "Garland" at the mouth of the Clyde estuary, in 54 fathoms, on September 22nd 1897. These specimens are now amongst the collection of fishes in the Fishery Board's Laboratory at Bay of Nigg.

Gadus virens, Linné. The Coal-fish or Saithe.

Moderately common and generally distributed, but mostly of small size. Full grown coal-fish do not appear to be very plentiful in the Clyde, but the young "podlies" sometimes occur in great numbers in inshore localities, as at East Loch Tarbert harbour and wharf.

Gadus pollachius, Linné. The Pollack or Lythe.

More or less frequent, but usually of small size; large specimens are occasionally brought to East Tarbert, Loch Fyne (B. & S.). The "Garland" also has records of lythe from Loch Fyne as well as off Sanda Island. The specimens from Sanda measured from 23 to 35 inches in length. *Gadus pollachius* has no barbel on the lower jaw.

Merluccius vulgaris, Cuvier. The Hake.

The hake is frequently captured in the Clyde by the "Garland" at all the Stations, as many as 108 having been caught in a single haul of the net; most of the specimens are more or less immature, but sometimes range from 30 to 40 inches.

Phycis blennioides (Brun.). The Greater Fork-beard.

The late Dr. Robertson of Millport, Cumbrae, recorded this species as having been taken near Cumbrae in April 1890.* Mr. Alex. Gray, of the Millport Marine Station, informs me that "the palate and forked fins of a specimen of *Phycis* are in the Robertson collections," and are probably portions of the fish referred to by Dr. Robertson, as they agree with the description he gave of the specimen which he recorded. Several specimens of the greater fork-beard have occurred on the coasts of the Solway Firth†, but it seems to be rare in the Clyde.

Proc. Nat. Hist. Soc. Glasgow, Vol. III. (N.S.), p. 276 (1892). This specimen measured 24 inches in length.

†Day, *British Fishes*, Vol. I., p. 304.

Molua molva, Linné. The Ling.

The ling, though not uncommon in the Clyde, is not very often captured by the "Garland," and rarely more than one or two specimens are obtained in any single haul made by the beam-trawl.

Onos mustela, Linné. The Five-bearded Rockling.

Taken between tide marks in East Loch Tarbert; not common (B. & S.).

Onos cimbrius, Linné. The Four-bearded Rockling.

"Very common, and generally distributed in the Clyde area at depths varying from 6 to 65 fathoms in April, to 70 and 90 fathoms in July and August, to 100 fathoms in November at Upper Loch Fyne and Kilbrennan Sound, at 37 to 46 fathoms in December," &c. (Günther). *Motella cimbria* is frequently captured in the shrimp-trawl of the Fishery steamer "Garland," but rarely in quantities, usually only one or a very few specimens being taken at one time.

Onos tricirratus, Bloch. The Three-bearded Rockling.

The three-bearded rockling has been taken in Rothesay Bay and other parts of the Clyde area, but appears to be rare. Part III. of the *Sixteenth Annual Report of the Fishery Board for Scotland* contains records of the capture of a few specimens in Upper Loch Fyne.

Onos maculatus, Risso. The Spotted Rockling.

"Loch Fyne, 40 fathoms; Mull of Cantyre, 65 fathoms" (Günther). This species somewhat resembles the last, but the front teeth are large. If *Onos tricirratus* and *maculatus* be really distinct species, the Clyde specimens should perhaps be all included under the latter name.

Raniceps raninus, Collet. The Lesser Fork-Beard, Tadpole Hake.

A specimen of the lesser fork-beard was recorded from Loch Fyne by the late Dr. Scoular.*

Fam. OPHIDIIDÆ, Müller.

Ammodytes lanceolatus, Le Sauvage. Greater Sand Launce or Sand Eel.

Taken occasionally in the neighbourhood of East Loch Tarbert (B. & S.). "Taken in the vicinity of Sanda Island, Sound of Sanda, Cantyre. The young numerous about the end of March" (Günther).

Fam. PLEURONECTIDÆ, Risso.

Hippoglossus vulgaris (Fleming). The Halibut.

The halibut is occasionally taken in Loch Fyne (B. & S.), but it is usually of small size.

Mr. Duthie, Fishery Officer at Girvan, states *in lit.*:—"Halibut are frequently got here in spring, though they cannot be called plentiful. On the 25th of March this year (1899) one boat landed four cwts., caught between Ailsa Craig and the Mull of Cantyre; the fish were of all sizes up to 112 lbs. or more—just what would have been a fair sample of Shetland-caught fish. I believe they are more plentiful in the neighbourhood of the 'Mull' than here, but an occasional fish is got all round this part of the Firth in the spring months when great-lines are

**Proc. Nat. Hist. Soc. Glasgow*, Vol. I., p. 8 (1868).

being used. Halibut are occasionally recorded at Ballantrae caught by cod or turbot nets. I have no doubt a stray specimen is also got between Arran and Ayr, although I do not at present remember of more than one cwt. being landed at Ayr this year."

Drepanopsetta plattessoides, Fabr. The Long Rough Dab.

"Many adults and young (2 inches in length) were obtained in 26 to 46 fathoms in Kilbrennan Sound in December. Many adults and young were also taken between Cumbrae and Wemyss Point in 30 to 40 fathoms in February 1888" (Günther). The long rough dab is very common and generally distributed throughout the Clyde area, especially off shore and in moderately deep water.

Bothus maximus (Linné). The Turbot.

"One captured in the Clyde area, August 28th, 1888; formerly numerous there" (Günther). Turbots have been taken in the trawl-net of the Fishery steamer "Garland" in the vicinity of Ailsa Craig, in the vicinity of Sanda Island, and in Kilbrennan Sound. Occasionally taken in Loch Fyne (B. & S.). There is a regular turbot fishery carried on off Girvan, a special net called the "turbot net" being used for the capture of the fish.

Bothus rhombus (Linné). The Brill.

The brill is rather more frequently recorded amongst the lists of fishes captured by the Fishery steamer "Garland" than the turbot, but mention is not often made either of the one or the other. The largest specimen of the brill referred to by Day is one recorded by Thompson, which measured 24 inches in length. The "Garland" has, however, obtained even larger specimens than that; one 25 inches was captured after nightfall at Station VII. on May 21st, 1897. A few measuring 21 and 23 inches have also been taken at different times.

Zeugopterus unimaculatus, Risso. One-Spotted Topknot.

"One specimen in 10 fathoms off Ardrossan, Clyde area, in April 1888" (Günther). Several specimens were captured in a shallow sandy bay at Barmore, Loch Fyne, in 1885 (B. & S.). Two of these specimens are still in the collection of fishes at the Fishery Board Laboratory, Bay of Nigg, Aberdeen.

Zeugopterus punctatus (Blainville). Müller's Topknot.

"Clyde area, 60 fathoms" (Günther). Upper Loch Fyne in 10 to 25 fathoms (M.). *Zeugopterus punctatus* has been taken in the trawl-net of the "Garland" in the vicinity of Ailsa Craig and in Kilbrennan Sound.

Rhombus norvegicus, Günther. The Norway Topknot.

Dr. Günther records the following specimens from the Clyde:—One dredged in Lamlash Bay at a depth of 6 to 18 fathoms, measuring 3¼ inches in length, and in excellent condition; one smaller than the last, caught off the Cloch Lighthouse in 43 fathoms; and one 3½ inches long, caught in Kilbrennan Sound in 45 fathoms. (*See* also Dr. Günther's description of the larger of these specimens.*) The Norway topknot is occasionally taken in the shrimp-trawl of the "Garland," but it appears to be a rare species in the Clyde.

**Proc. Roy. Soc. Edin.*, Vol. XV., p. 47 (1888).

Lepidorhombus megastoma, Donovan. The Sail Fluke or Whiff.

The sail-fluke is recorded for the Clyde area by Dr. Günther (1886). It is a species that does not appear to be very rare in the Clyde area, especially in the seaward portion of it, and is more or less frequently mentioned amongst the captures of fishes made by the "Garland"; it is especially frequent at Stations VIII., IX., and X.

Platophrys laterna, Walbaum. The Scald Fish.

Recorded for the Clyde area by Dr. Günther (1888). Taken in the trawl-net of the "Garland" between Sanda Island and Bennan Head. This species appears to be a comparatively rare one in the Clyde estuary; a few specimens were taken last year (1899) at Stations II., V., VI., VII., VIII., and X.

Pleuronectes platessa, Linné. The Plaice.

This is a moderately common and generally distributed species from the head of Loch Fyne to the seaward limits of the Clyde estuary.

Pleuronectes microcephalus, Donovan. The Lemon Dab; also called Lemon Sole and Smooth Dab.

Clyde area, feeding on annelids and *solens* (Günther). The lemon sole is more or less frequent and generally distributed throughout the estuary of the Clyde, especially off shore. Annelids appear to constitute the principal food of the lemon sole, at least in Scottish waters, as shown by the investigations that have been made concerning fish-food on board the Fishery steamer "Garland."

Pleuronectes cynoglossus, Linné. The Witch Sole, Craig Fluke, Pole Dab.

This appears to be the most common of the flat fishes in the Firth of Clyde, especially in the deep water. Dr. Günther records its occurrence at a depth of 80 to 100 fathoms in Loch Fyne. It is most abundant at Stations III., VII., VIII., IX., XI., XII., XV., and XVII.; nearly 400 have been got in a single haul in Loch Fyne. Its food, like that of the lemon sole, consists chiefly of annelids, and it is probably on this account that the species is usually more common on a muddy bottom.

Pleuronectes limanda, Linné. The Common Dab.

Pleuronectes limanda is also one of the more common of the Clyde fishes, and seems to be distributed all over the estuary to the head of Loch Fyne, and probably also throughout the other sea-lochs within the Clyde area (Günther). It is got at all the "Garland" Stations.

Pleuronectes flesus, Linné. The Flounder or Fluke.

Common in Tarbert Harbour, Lower Loch Fyne (B. & S.). Occasionally obtained in Upper Loch Fyne (G.). One was captured off Largymore, Upper Loch Fyne, on April 28th, 1896, and a few have been captured in other parts of the loch with the push-net; but it seems to be a rare fish in the more seaward portion of the Clyde.

Solea vulgaris, Quensel. The Sole or Black Sole.

The black sole is occasionally taken in the trawl-net of the "Garland" at all the Stations, except in Loch Fyne; there are seldom more than one or two specimens, but occasionally ten or twelve, in a haul. It is more difficult to capture black soles during daylight than after darkness sets in. The food of the black sole appears to consist largely of annelids.

Solea variegata, Donovan. The Variegated Sole or Thickback.

"Two immature specimens were obtained in the vicinity of the Mull of Cantyre in 65 fathoms on March 21st, 1888" (Günther, p. 220). Two specimens, one about 3½ inches long, the other slightly less, were captured near the mouth of the Clyde estuary at Station VI., on June 15th, 1899. They were taken with the shrimp-trawl of the "Garland," and are now in the collection in the Laboratory at Bay of Nigg.

Solea lutea, Risso. The Solenette or Little Sole.

The solenette has been recorded amongst the fishes captured by the "Garland," but appears to be rare in the Clyde.

Order PHYSOSTOMI, Müller.

Fam. SALMONIDÆ, Müller.

Salmo trutta (Fleming). The Sea Trout.

The sea trout is regularly taken in small quantities just outside East Loch Tarbert (B. & S.). A fine specimen, which, I understand, had been captured in the Clyde, was kept in one of the tanks in Rothesay Aquarium when I was there in 1886-87.

Salmo salar, Linné. The Salmon.

There are regular fisheries for salmon at various parts of the Clyde estuary, including the several sea lochs. The salmon is taken occasionally in herring-nets between Tarbert and Barmore, and probably also in other parts of the Clyde.

Osmerus eperlanus, Linné. The Smelt.

"One was taken with mussel-bait at Brodick, Arran, October 1888. Not uncommon" (H.B., p. 218).

Argentina sphyræna, Linné. The Hebridean Smelt.

"Three specimens were obtained in 32 fathoms between Little Cumbrae and Brigaird Point on February 7th, and five obtained in 37 fathoms in Loch Striven on February 15th, 1888" (Günther). The Hebridean smelt is not very rare in the Clyde estuary, when sought for with suitable apparatus; it is frequently taken with the shrimp trawl-net of the Fishery steamer "Garland," as many as seven specimens having been captured in a single haul; usually, however, only one or a few are obtained at one time.

Fam. SCOMBRESOCIDÆ.

Rhamphostoma belone. The Garfish.

A specimen of the garfish, 28 inches in length, was taken off Dunoon on May 25th, 1877 (Dr. F. P. Fleming).* It is taken in the Clyde area occasionally in shoals (H.B., p. 212). A young specimen was captured in the surface tow-net of the "Garland" in Loch Fyne.

Scombresox saurus, Walbaum. The Saury Pike.

Taken in the Clyde area (H.B., p. 212). We have not yet had the good fortune to capture this species, either in the immature or adult stages.

* This record is referred to in Dr. Day's *British Fishes*, Vol. II., p. 150.

[(?) *Exocetus volitans*, Linné. The Flying-fish.

The Rev. David Landsborough, in his *Natural History of Arran*, p. 386, states that the flying-fish has been seen in Ayr Harbour. Two or three kinds of fishes are spoken of as "flying-fish," but probably it is the species named above that he refers to.]

Fam. CLUPEIDÆ, Cuvier.

Clupea harengus, Linné. The Herring.

Common in the Clyde and Loch Fyne, where a great herring fishing is carried on. The movements and habits of the Clyde and Loch Fyne herring have been for a long time subjects of much interest to naturalists, and even yet are not very clearly understood.

Clupea sprattus, Linné. The Sprat.

Sprats are not uncommon in the Clyde, but owing to their having been frequently mistaken for young herring, there is some uncertainty as to their numbers and distribution.

Clupea alosa, Linné. The Allis Shad.

Very large specimens were taken in Loch Fyne in 1888 (H.B., p. 221). Mr. Gray, of the Millport Marine Station, says *in lit.*:—"A fine specimen of this fish was taken in a seine-net off Isle of Ross in the winter of 1894, and was put in spirits by me and left in the old museum in Kirk Street, Campbeltown, and is probably still preserved in the new museum there."

Fam. MURÆNIDÆ, Müller.

Anguilla vulgaris, Cuvier. The Common Eel.

The Common Eel affords a small but regular fishery in Tarbert harbour, Loch Fyne (B. & S.). It was also taken in the shrimp trawl-net of the "Garland" off Inveraray in May 1896.

Conger vulgaris, Cuvier. The Conger.

Moderately large specimens of conger are at times captured in the "Garland's" beam trawl-net, one 50 inches in length was taken near the head of Loch Fyne on May 5th, 1896; another of the same length was secured in the vicinity of Ailsa Craig on April 28th, 1897. A specimen 45 inches long is recorded from Whiting Bay, and others of somewhat smaller size from various parts of the Clyde area. I have taken a fairly big specimen between tide marks at Lunderston Bay after the tide had ebbed.

Order LOPHOBRANCHII, Cuvier.

Fam. SYNGNATHIDÆ.

Siphonostoma typhle (Linné). The Deep-nosed or Broad-nosed Pipe-fish.

A specimen of this species was captured amongst *zostera* in East Loch Tarbert (B. & S.). A specimen, which I believe to be the one now recorded here, is in the collection of fishes in the Fishery Board's Laboratory at Bay of Nigg.

Syngnathus acus (Linné). The Great Pipe-fish.

This species is not uncommon in the Clyde and Loch Fyne, especially inshore where the water is shallow.

Nerophis æquoreus (Linné). The Straight-Nosed Pipe-fish.

East Loch Tarbert, amongst *zostera* (B. & S.). A fine specimen is in the Robertson collection in the Marine Station at Millport, which was captured at Cumbrae.

Nerophis lumbriciformis (Linné). The Worm Pipe-fish.

Taken in East Loch Tarbert amongst *zostera* (B. & S.). I have taken this little fish amongst weed between tide marks in Lunderston Bay, near Inverkip, and it has also been taken by the "Garland" in Campbeltown Loch, Cantyre.

Hippocampus antiquorum, Leach. The Sea-horse.

Mr. Gray, of the Marine Station at Millport, writes to me concerning this species as follows :—"I picked up a specimen of *Hippocampus* on the Kinloch Park, Campbeltown, in the autumn of 1894, from a spot where herring seine-nets had been spread out to dry, and from the fresh condition of the fish I had no doubt whatever that it had been caught in the nets in the Sound of Kilbrennan, and been shaken out on the spot where I found it. Still I did not see it alive, so there is room for the element of doubt to creep in ; though this evidence, therefore, may not be quite conclusive, I have very little doubt in my own mind of the little fish having been caught in the Kilbrennan Sound. Moreover, I may mention, by way of confirming what has just been said, that during the past summer a gentleman visitor to the Marine Station told me that many years ago his own children caught two live *Hippocampus* in a pool on the Fairlie sands, and kept them alive for about a week in a vessel of sea-water. I took the gentleman to Mrs. Robertson of Fernbank, who happened at the time to be in the museum connected with the station, and to her he repeated the story also. Since then I feel more firmly convinced that the Campbeltown specimen was a genuinely local one."

Hippocampus has been recorded from Belfast Lough, which is not very far distant from the mouth of the Clyde; and the same species is also recorded for the West Coast of Scotland in Harvey-Brown and Buckley's work on the *Vertebrate Fauna of Argyle and the Inner Hebrides.*

Order PLECTOGNATHI.

Fam. GYMNODONTES.

Orthagoriscus mola, Linné. The Short Sun-fish.

A specimen of the short sun-fish was captured off the Esplanade at Greenock on September 10th, 1881 (J. M. Campbell).* This specimen was said to weigh about a ton; it measured 7 feet 9 inches in length and 3 feet 9 inches in height. Mr. Campbell states that "the liver was absolutely crammed with a scolecid worm, *Tetrarhynchus reptans.*"

SUB-CLASS CHONDROPTERYGII.

Order GANOIDEI.

Fam. ACIPENSERIDÆ.

Acipenser sturio, Linné. The Sturgeon.

Fine specimens are often noticed in Loch Fyne during the herring fishery, but are seldom captured (B. & S.). Mr. Alexander Gray, of the

* *Proc. Nat. Hist. Soc., Glasgow*, Vol. V., pt. II., p. 177 (1883).

Marine Station, Millport, in a letter to me concerning some Clyde fishes, says that "a sturgeon was caught near Carradale in 10 to 12 fathoms of water; it was about 7 or 8 feet long, but in poor condition, and was sold in the Glasgow market by Mr. Lagan of Paisley for £1 15s. So far as I can recollect, this was in the late autumn of 1895. A few years previous to this I remember seeing another sturgeon, perhaps 5 or 6 feet long, that was caught in a salmon-net at Penimore Bay; I had no opportunity to examine this specimen, as it was shipped on the steamer ready for conveyance to the Glasgow market when I saw it."

Order ELASMOBRANCHII.

Fam. CARCHARIIDÆ.

Carcharias glaucus, Linné. The Blue Shark.

This shark has been taken in Loch Fyne (H.B., p. 177). Mr. A. B. Watt of Glasgow saw a specimen of *Carcharias* which had come ashore at Ayr Bay on the 11th or 12th September last year (1899).

Galeus canis, Rondel. The Tope or Toper.

Several specimens of this species were landed at Girvan in December last. They were at the time mistaken for another species, but were subsequently correctly identified as the tope. I am not aware of this species having been previously recorded for the Clyde; probably it is only an occasional visitor to the estuary, and may on former occasions have been passed over as one of the more common species. A fine specimen of toper was brought to Girvan by a local fisherman on December 28th. It was examined by Mr. Duthie, the Fishery Officer at that place, who was able to identify the species; the specimen measured 5 feet in length and 24 inches in circumference at the thickest part. Mr. Duthie was kind enough to secure the specimen and forward it to the Laboratory at Bay of Nigg, and I was thus enabled to verify Mr. Duthie's identification. The specimen was a female.

Fam. LAMNIDÆ.

[*Alopias vulpes* (Gmel.). The Thrasher or Fox Shark.

Captain Campbell, of the Fishery steamer "Garland," informs me that a year or two ago he was proceeding down Loch Fyne, and, having reached a point somewhere between Crarae and Castle Lachlan, but rather nearer the former place, he saw a thrasher making an attack on what was probably a cetacean of some kind; the thrasher was leaping clear out of the water in its usual way when engaged at this kind of work, and was coming down with a slap, the sound of which could be heard distinctly on board the vessel. Captain Campbell knows the thrasher quite well, and has frequently, when voyaging across the Atlantic, been an eye-witness of its tactics, so that there is little likelihood of his having been mistaken about the fish he saw in Loch Fyne.

My friend Mr. Gray of Millport tells me that in July 1895 a thrasher shark got into shallow water in Machrihanish Bay, and that some men there put off in a boat and, with ropes, managed to entangle it and haul it ashore close to the Pans Hotel. This specimen, which measured 15½ feet in length, was seen by Mr. Gray soon after it was captured. Machrihanish, though not within the Clyde area, is only a few miles west from Campbeltown, and comparatively near the mouth of the Clyde, and tends to show that the *Alopias* may occasionally find its way into the Clyde estuary.]

Selache maxima (Gunner). The Basking Shark.

A young specimen measuring 8 feet in length was captured in Maidens Bay, near Turnberry, Ayrshire (*Scotsman* newspaper, September 26th, 1898). This record was confirmed by the Fishery Officer at Girvan. Dr. Landsborough, in his *Natural History of Arran*, refers to the occurrence of this fish in the Clyde, and says (pp. 95, 96):—"A century ago . . . it was a frequent visitor to the Clyde, and was taken at Ballantrae, in Ayrshire, as well as in Arran. It made its appearance in the first or second week in June, and generally remained only for three or four weeks, though occasionally seen considerably later. . . . Now it is seldom seen." Dr. Landsborough also describes the means by which the fishermen of Arran usually captured these sharks.

Fam. SCYLLIIDÆ.

Scyllium canicula (Linné). The Lesser Spotted Dog-fish, Rough Hound.

"A very young specimen, 8 inches long, was obtained in the Sound of Sanda, at a depth of 20 fathoms" (Günther). Two specimens, each about 25 inches in length, were captured by the "Garland" at Station I, Firth of Clyde, on May 25th, 1897, and three specimens, measuring respectively 25, 28, and 29 inches in length, were captured on the same day in the vicinity of Sanda Island. In a male specimen 12¾ inches long taken in 60 fathoms between the Mull of Cantyre and Corsewall Point on May 15th, the spots are distinctly larger than they are on the adult specimens, especially on the anterior portion of the body. This specimen is now in the collection of fishes in the Fishery Board's Laboratory, Bay of Nigg, Aberdeen.

[*Scyllium catulus*, Cuvier. The Larger Spotted Dog-fish, Nurse Hound.

The following notice appeared in the *North British Daily Mail* of December 11th, 1899:—

"One of the Girvan great-line boats on Saturday, the 9th inst., had an unusual catch of dog or hound sharks. No fewer than seven were caught in the great-lines, set in Lendal Bay, south of Girvan. Some of them measured about 5 feet in length and 24 inches in girth. The species is known as *S. catulus*, or rock shark. The females were full of well-developed eggs. Where they abound they are most destructive to the fishermen by taking their bait and hooks off the lines. The fish were cut up for bait for the crab and lobster creels."]*

Pristiurus melanostomus (Bonaparte). The Black-Mouthed Dog-fish.

"Two adult males in Upper Loch Fyne, 37 fathoms" (Günther). One captured by a Cumbrae fisherman was exhibited at a meeting of the Natural History Society of Glasgow on January 26th, 1869. The black-mouthed dog-fish is occasionally brought into East Tarbert amongst the *Acanthii* in the winter fishing (B. & S.). Upper Loch Fyne, in 10 to 20 fathoms (M.). Captured by the "Garland" in the deep water between Arran and Turnberry Point.

Fam. SPINACIDÆ.

Acanthias vulgaris, Risso. Picked Dog-fish.

Sometimes of common occurrence in the Clyde and Loch Fyne,

*There appears to have been some mistake on the part of the writer of the above note concerning the name of the fish landed at Girvan on December 9th. I am able to state conclusively that the fish landed were Tope or Topers, *Galeus canis*, and not *Scyllium catulus* as stated (see page 289). I have been unable hitherto to obtain any satisfactory information as to the occurrence of the Larger Spotted Dog-fish within the Clyde estuary.

especially during the herring fishing. Few of those taken by the "Garland" are of large size; they seldom reach beyond 2 feet in length; whereas the picked dog-fish is stated by Day to attain a length of at least 4 feet off our shores; but such large specimens are probably of exceptional occurrence.

Fam. RHINIDÆ.

Rhina squatina (Linné). The Angel-fish or Monk-fish.

"In the Firth of Clyde it is by no means uncommon, and is frequently found there after gales; one was harpooned while asleep, but broke away."* This appears to be the only Clyde record for the angel-fish hitherto published. In the *Vertebrate Fauna of Argyle and the Inner Hebrides* it is stated that two specimens of the angel-fish in the Hunterian Museum, Glasgow, are from the West Coast, but no locality is given for them.

Mr. Wright, the chief Fishery Officer for the Barrow-in-Furness district of the Lancashire Sea Fisheries, states that he trawled in the Clyde for about eighteen winters previous to the closing of the estuary to that mode of fishing, and that during that time he occasionally captured angel-fish on the Ballantrae Bank. He knows the fish very well, and has brought specimens from Morecambe Bay to the Sea Fish Hatchery at Piel. The name he uses for the angel-fish is the "abbot."

Fam. RAIIDÆ.

Raia batis, Linné. The Skate, the Grey Skate or Blue Skate.

Moderately common and generally distributed, especially off-shore. Those captured by the "Garland" are seldom of large size, being usually mere pigmies when compared with the immense specimens sometimes landed at the fish market at Aberdeen. The largest taken by the "Garland" in the Clyde rarely exceed three feet in width.

Raia intermedia, Parnell. The Flapper Skate.

"A female with a disk 19 inches wide was obtained between Sanda Island and Ailsa Craig in 24 fathoms, March 6th, 1888" (Günther). The flapper skate has been taken by the "Garland" in the deep water to the east of Arran, and also in the vicinity of Ailsa Craig. (This is the *Raia macrorhynchus* of Day's *British Fishes*.)

Raia oxyrhynchus, Linné. Long or Sharp-nosed Skate.

Two specimens were captured by the "Garland" in the deep water to the east of Arran; both were comparatively small, one being only 21 inches and the other 29 inches across the pectoral fins.

Mr. Duthie, Fishery Officer, Girvan, informs me that on February 1st (1900) he saw a fine specimen of the long-nosed skate which had just been sent to Girvan from Maidens Village—a village not far from Girvan. The following measurements were taken by Mr. Duthie—Extreme length, 51 inches; extreme breadth, 34 inches; length from tip of snout to centre of closed mouth, 13 inches; length of tail, 18 inches; while from the tip of the tail to the vent was 21 inches.

Raia fullonica, Linné. Shagreen Ray, Fuller's Ray.

"A female example, 24 inches across the disk, from Loch Fyne, off Skate Island, was obtained in 100 fathoms. An adult male, 19 inches across the disk, was caught in Kilbrennan Sound in 20 fathoms"

*A. Norman, *Zoologist*, Vol. XV. (1857), p. 5366.

(Günther). The shagreen ray is occasionally captured by the "Garland," but is apparently not very common in the Clyde.

Raia clavata, Linné. Thornback Ray or Thorny.

"One adult female was obtained in 26 fathoms in Kilbrennan Sound, and an immature male 17 inches wide in 24 fathoms between Sanda Island and Ailsa Craig. The contents of the stomach of the latter specimen consisted of small fish and crustaceans" (Günther). The Thorny is one of the more common of the fishes captured in the Clyde by the Fishery steamer "Garland," but the specimens are mostly of small size, and very few of them extend beyond 25 or 30 inches across the disk.

Raia maculata, Montagu. The Spotted Ray, or Homelyn Ray.

"An immature female was captured between Cumbrae and Wemyss Point in 30 to 40 fathoms. Another from the Sound of Sanda from 20 fathoms. One or two very young specimens from 2½ to 4½ inches across the disk were obtained off Ardrossan and off Whiting Bay" (Günther). The spotted ray is occasionally captured by the "Garland," but the specimens are usually of small size. One measuring 18 inches across the disk was taken in the vicinity of Ailsa Craig on April 27th, and one 10 inches across the disk at Station VI. on May 25th, 1897. A small specimen a little over 7 inches across the disk is in the collection of fishes in the Laboratory at Bay of Nigg.

Raia circularis, Couch. The Cuckoo Ray, Sandy Ray.

"An adult male, 14 inches across the disk, and a very young female, 3⅔ inches broad, were obtained in the Sound of Sanda at a depth of 20 fathoms on March 10th; another adult male, also from the Sound of Sanda, was obtained at 49 fathoms on March 17th, 1888" (Günther). The cuckoo ray has been taken by the "Garland" in Whiting Bay, in the vicinity of Sanda Island, in the vicinity of Ailsa Craig, and in various parts of Upper Loch Fyne. It does not appear to be a very rare fish in the Clyde area.

SUB-CLASS CYCLOSTOMATA.

Fam. Myxinidæ.

Myxine glutinosa, Linné. The Hag-fish.

The hag-fish has been taken at Rothesay in the Clyde area. It is said to be numerous and most destructive to the line fishes off Girvan (H.B., p. 225). I do not remember having seen *Myxine* in the Clyde.

SUB-CLASS LEPTOCARDII.

Fam. Cirrhostomi.

Branchiostoma lanceolata, Pallas. The Lancelet.

"Amphioxus" is "taken plentifully in suitable ground in the Clyde area" (H.B., p. 225). Mr. Gray, of the Millport Marine Station, states, in a letter to me, that "over a dozen specimens of this little fish were taken on a bank between Little Cumbrae and Hunterston, locally known as the *Dogger Bank*." Dr. James Bryce, in his *Geology of Arran and Clydesdale* (1865), p. 250, remarks that the *Amphioxus* has been dredged at the north end of Holy Island, and has been obtained in Lamlash Bay, as well as near Millport. Dr. Landsborough also speaks of having found it when dredging near Cumbrae.

VII.—ON THE MACKEREL OF THE EAST AND WEST COASTS OF SCOTLAND.

By H. Chas. Williamson, M.A., B.Sc.

The present research was undertaken with a view of determining whether or not racial differences existed between the mackerel of the West and East Coasts of Scotland. The method employed is that of separating local forms by the averages of the size, or numbers of certain characters. This method, first employed by anthropologists in the examination of the races of man, has been applied by Heincke* to the division of the herring into local forms.

The principles upon which the division of a species into races is carried out, and certain of the theories bearing upon the formation of the local form or race, will be found detailed in Heincke's work.

All the characters of an individual are variable. If, then, we find that the mean of the variations of a certain character in one group differs from their mean in a second group, we are entitled to regard this as a racial distinction between the two. It is necessary to select a number of characters, *e.g.*, the number of the vertebræ, the numbers of fin-rays, measurements on the body, etc., as tests by which the groups may be compared. The greater the number of individuals in each group, the more nearly correct will be the mean (or average). Since, however, we cannot examine all the members of a race we cannot get the true mean directly. By experiment and observation we get a mean which is more or less approximate. From this observed mean we may get two values between which the true mean lies. This is obtained from the Probability curve. One of these two values is obtained by subtracting and the other by adding the probable error of the mean to the observed mean. The two values are represented by the formulæ $M-r$, and $M+r$, where M is the observed mean and r is the probable error. In order to get a result which is almost absolutely correct, in place of r, five times r is subtracted and added, viz., $M-5r$, and $M+5r$. According to Heincke there are 999 chances to 1 that the true mean lies between these limits. The interval between these values is known as the fluctuation of the mean. If now we find that the fluctuations of the means of a character in two groups do not overlap, we are entitled to conclude that the true means are different from one another, and therefore so far as this character is concerned the two groups are of distinct races.

The Mean, the Probable Error of the Mean, the Standard Deviation are obtained from the following formulæ, which have been taken from Davenport's "Statistical Methods," Chapman & Hall, 1899.

The Standard Deviation, $\sigma = \frac{1}{n}\sqrt{n\Sigma(d^2 f)-(\Sigma d)^2}$

The Probable Error of the Mean, $r = \cdot 6745 \cdot \frac{\sigma}{n}$

n = number of variants; d = deviation from the mode:

The Standard Deviation σ is a measure of the range of Variation.

As bases of comparison between the mackerel of the East and West Coasts, the following characters were selected:—

* "Naturgeschichte des Herings," Berlin Otto Salle, 1898, text, 1 Hälfte.

I. GIRTH of BODY at three points—(1) pectoral region, close to the hind border of the operculum (*G.* Pect.*), (2) at the beginning of the second dorsal fin (*G.* 2nd D.), (3) at the narrowest part of the root of the tail (*G.* T.). The measurements were made by means of a thread.

II. The length of the DORSAL GROOVE (*l* D. groove), which encloses the base of the first dorsal fin.

III. The length of the PECTORAL FIN (*l* Pf.), measured from the proximal end of the first or superior ray to the tip of the fin.

The following are measurements made on the lateral axis ("principal axis" of Heincke). The lateral axis is a line drawn from the tip of the mandible, when the mouth is closed, to the middle of the fork of the tail. From certain points on the body of the mackerel (*vide* diagram), perpendiculars were drawn to the lateral axis, 0a. The distances from zero (the tip of the snout) to the points where the perpendiculars cut the axis were measured. These dimensions are as follows:—

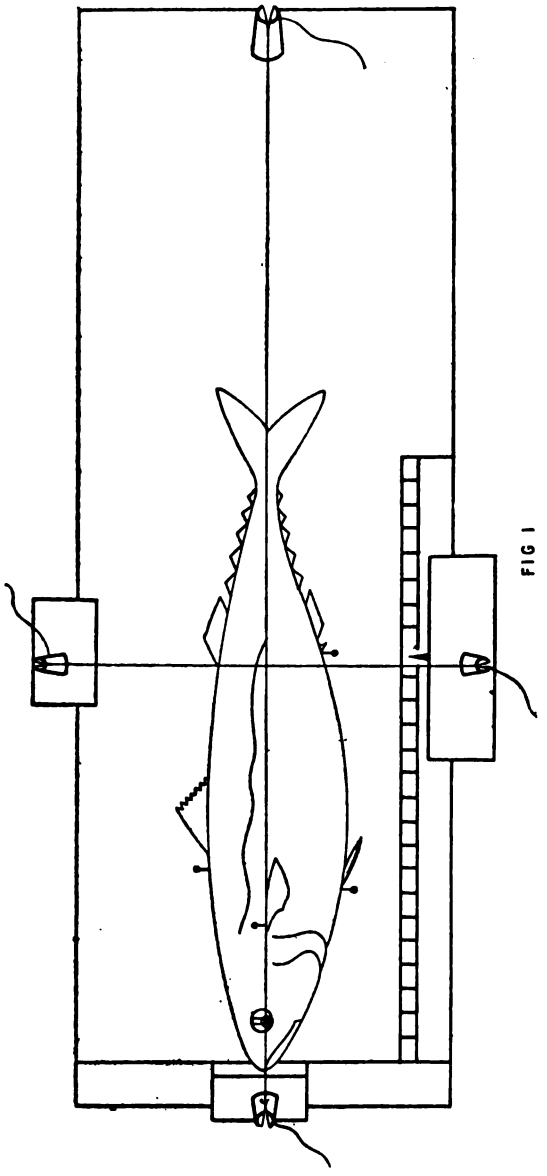


FIG 1

* These symbols refer to the headings in the Tables appended.

IV. Length of Snout; from zero to the point where the perpendicular from centre of the eye cuts the axis, *l* Sn.

V. Lateral Length of Head; from zero to the point where the perpendicular from the hind edge of the operculum cuts the axis, *ll* H.

VI. Distance of Pectoral Fin; from zero to the point where the perpendicular through the proximal end of the first ray of the fin cuts the axis, *d* Pf.

VII. Distance of Ventral Fin; from zero to the point where the perpendicular through the proximal end of the first or outer ray of the ventral fin cuts the axis, *d* Vf.

VIII. Distance of First Dorsal Fin; from zero to the point where the perpendicular from the anterior edge of the base of the first dorsal cuts the axis, *d* 1 D.

IX. Distance of Second Dorsal Fin; from zero to perpendicular from the anterior edge of the base of the second dorsal, *d* 2 D.

X. Distance of the Anus; from zero to perpendicular from the hind edge of the anus, *d* A.

XI. Distance of Anal Spine; from zero to the perpendicular from the anal spine, *d* As.

XII. Length of Skull; from the edge of the occipital foramen to the tip of the ethmo-palatine boss, *l* Sk.

XIII. Length of Mandible; from the extremity of the articular to the tip of the mandible, *l* M.

XIV. Length of Dentary; the length of the ossified portion of the dentary, *l* De.

XV. Length of the Tail; measured from the anterior edge of the 31st vertebra to the tips of the shortest rays in the fork of the tail, *l* T.

XVI. Length of Superior Lobe of the Caudal Fin; measured from the superior hind edge of the 29th vertebra to the extreme tip of the lobe of the fin, *l* Cr.

In addition to the preceding, the following characters which admit of enumeration were chosen:—

XIX. The Number of Vertebræ.

XX. The Number of Rays in the First Dorsal Fin.

XXI. ,, ,, ,, Second ,, ,,

XXII. ,, ,, ,, Anal Fin.

XXIII. ,, Dorsal Finlets.

XXIV. ,, Anal ,,

XXV. Weight.

The Length of the fish was taken as the distance from the tip of the snout to the middle of the fork of the tail. This standard was adopted by Garstang.*

Mode of Measurement.

Since there are not on the mackerel external marks by which the origin of any of the fins may be sharply defined, it was necessary to select certain artificial points which would enable the measurements to be made all through with some degree of uniformity. The distances on the body were measured from the one origin—viz., the tip of the snout. To mark the beginning of the pectoral fin a pin was inserted at the angle between the base of the first ray and the scapula (3, fig. 3); the same point was used in the measurement of the length of the pectoral fin, the other limit being the extreme tip of the same; for the beginning of the ventral fin a pin was inserted at the angle between the first or outer ray of the ventral fin and the ventral surface of the body (4, *ib.*); the beginning

* Garstang, "On the Variation, Races, and Migrations of the Mackerel (*Scomber scombrus*)," *Journal Marine Biological Association*, N.S., Vol. V., No. 3.

of the first dorsal fin was indicated by a pin which was introduced immediately in front of the first dorsal ray, between it and the anterior border of the dorsal groove (5, *ib.*); a slight cut made with a scalpel, close in front of the first ray, was taken as the commencement of the second dorsal (6, *ib.*). The anus was located by means of a pin inserted into, or as near as possible to, the genital aperture (7, *ib.*). The length of the snout was obtained by measuring the distance from the tip of the snout to the point where the perpendicular from the anterior edge of the pupil cut the lateral axis, and adding thereto half the diameter of the pupil (1, *ib.*). Since the eye is kept in place by two adipose lids which partly overlap, it was almost without exception found to be fixed in a uniform manner.

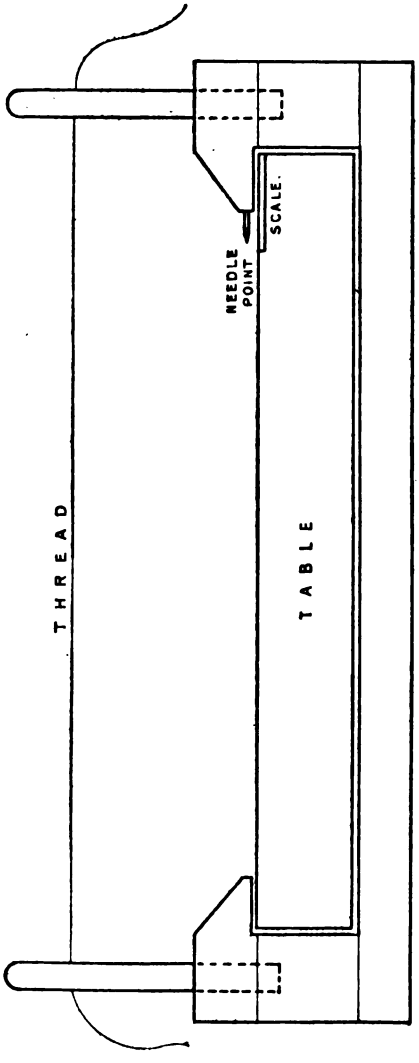


FIG 2

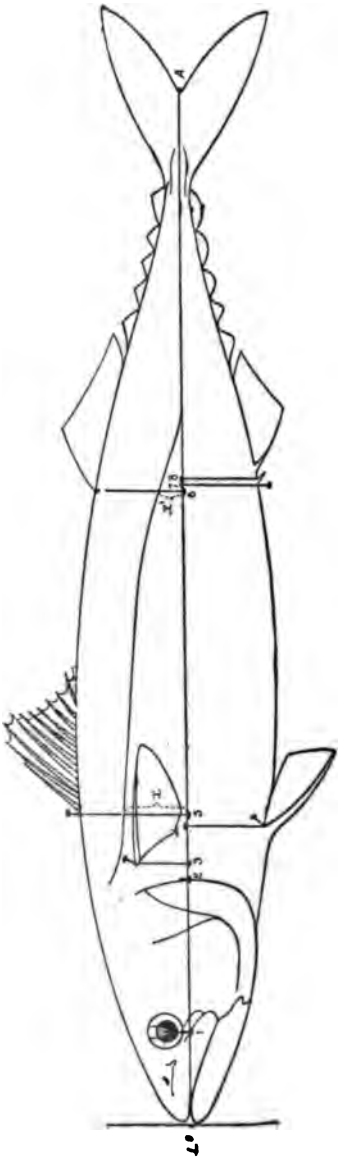


FIG 3

Measuring Board.

In order to readily obtain the points at which the perpendiculars from the different points cut the lateral axis, a board (*vide* figs. 1 and 2), which served this purpose with a considerable amount of accuracy, was constructed. The apparatus was furnished with a movable frame, carrying a thread which cut the lateral axis at right angles. This frame could be moved from one end of the board to the other, and could thus be brought exactly over each selected point in succession. The two supports which received the ends of the thread were connected together by a wooden cross-piece that held them firmly united. The near support was shaped as the base of a T square, so that when it was pushed up against the edge of the board the thread crossed the same at right angles. The edge of this support moved over a millimetre scale. A needle point was inserted in this edge, immediately below the thread. The frame was moved along until the pin that marked the point on the fish, the thread, and the needle point were in the same plane. The distance was, with the aid of the needle point, then read off on the scale. The thread could be raised or lowered to suit the varying thickness of the fish. At either end of the board there was a support which received one end of a thread which traversed the board longitudinally. This represented the lateral axis of the fish, and was drawn parallel to the edge of the board. The lateral axis was also represented by a groove cut in the board itself. The fish, when ready for measurement, was placed on the board with the anterior tip of the mandible and the middle of the fork of the tail exactly on the lateral axis, so far as could be judged by the eye. The tip of the mandible was in contact with the upright at the zero point of the scale. The distances were accurately measured to half a millimetre. The measurements of the skull, mandible, and dentary were made by means of callipers, the fish having been first boiled. Other dimensions—*e.g.*, length of tail, etc.—were got by the aid of dividers. It has been necessary to go into a minute description of the modes of measurement, for it is very evident that unless there is uniformity in taking the dimensions no comparison of any value can be made between their Means.

The mackerel were sent from the West Coast to Aberdeen in ice, and, with the exception of a few which were examined immediately, were put into the cold-storage room of a local ice-factory. There they were kept until they were required. The Aberdeen fish were similarly stored.

Shortcomings in respect to the Measurements.

It was not possible to measure every one of the characters which appear in the list given above on each fish. Some of the fishes, through damage or contortion, were unsuitable for certain measurements, and, as will be seen from the Tables appended, the number of fishes in which each character was noted varies considerably. In the case where the fish is damaged, or is much contorted, the measurements which would be affected thereby can be neglected, but where the fish does not show any sign of damage there may, however, be a certain amount of contortion, which will affect the accuracy of the measurements. This slight contortion, which is not apparent, and which usually occurs at the neck or in the anterior part of the trunk, may have a considerable effect on the disposition of the soft parts, and consequently on such characters as the distance of the fins from the tip of the snout. The contortion has the effect of shortening these distances. The true distance of any of these characters is to be got only when the dorsal fins, tail fin, and centre of the tip of the snout are in the same plane, which, when the fish is swimming, is vertical. Any

flexure of the body to the right or left shortens the distances taken—namely, the projections of the distances on the lateral axis. A certain amount of evidence bearing upon the extent to which contortion may give rise to error is afforded by six mackerel, which were used to test the effect of freezing on the dimensions of the body. The following Table gives a comparison between the measurements taken in the fresh state, and the measurements found for the same characters after the fishes had been in the cold-storage-room for twenty-five days:—

[TABLE.

TABLE I.—MEASUREMENTS IN CENTIMETRES.

		Length, cm.	Girth.			Dorsal Groove.	*l* Pf.	*l* Sn.	*U* H.	*d* Pf.	*d* Vf.	*d* 1 D.	*d* 2 D.	*d* A.	*d* As.	Sex.	Weight, Gmme.
			Pect.	2nd D.	T.												
1	Before . . .	36·4	15·5	15·7	3·5	6·1	3·9	3.02	7·7	7·95	9·75	10·6	23·4	23·25	23·5	♀	598
	After . . .	36·05	15·5	15·4	3·1	.	3·9	3·07	7·75	8	9·65	10·6	23·3	23·15	23·5		580
2	Before . . .	35	14·6	14·6	3·3	5·3	3·8	3	7·65	8·1	9·4	10·55	22·4	22·6	22·9	♀	482
	After . . .	34·65	14·4	14·5	3	5·45	3·75	3·05	7·55	7·9	9·3	10·45	22·2	22·3	22·55		471
3	Before . . .	33·8	15	14·2	3	6	3·65	3·15	7·75	8·05	9·7	10·6	21·7	22	22·3	♂	478
	After . . .	33·55	14·8	14·2	2·85	5·8	3·65	3·12	7·7	8·05	9·5	10·7	21·5	22	22·2		470
4	Before . . .	34·2	14·3	13·8	3	4·8	3·6	3·22	7·95	8·3	9·6	10·55	21·7	21·8	22·1	♀	432
	After . . .	33·95	14·3	13·4	2·8	4·95	3·6	3·27	7·95	8·35	9·5	10·6	21·7	21·9	22·1		422
5	Before . . .	35·4	15·3	14·9	3·2	5·9	4	3·02	7·9	8·1	9·7	10·65	22·45	22·6	23	♂	520
	After . . .	35	15·1	14·1	3	5·75	3·9	2·9	7·6	7·85	9·5	10·4	22·15	22·2	22·55		504
6	Before . . .	34·1	14	14·2	3·1	5·4	3·6	3·02	7·55	8	9·5	10·4	21·65	21·8	22·1	♂(?)	439
	After . . .	33·75	.	.	.	5·5	3·65	2·92	7·45	7·8	9·55	10·05	21·4	21·25	21·55		428

When the mackerel were sent to the store the pins which had been used in marking the limits of the dimensions were left in the fish. It was thus possible on re-examination to measure to exactly the same points. Any change found in the dimensions was due then to alteration in the fish. It was found that a shrinkage had taken place in length, in amount about 1 per cent. The fishes had lost in weight, in amount, 1·7, 2·3, 2·5, 2·5, 3, and 3 per cent. respectively. It might have been inferred that, in consequence of the shrinkage in length, a proportional decrease would have been found in the various measurements. But this was not so; for while in certain cases exactly the same measurement was obtained, in others the alteration in the dimension was greater than the total shrinkage in length of the fish. In the case of the girth, that in the pectoral region showed a decrease of 2mm. in some cases; at the second dorsal a decrease of as much as 8mm. was found in the case of No. 5—in no example was this exceeded; and in the girth at the root of the tail a shrinkage of as much as 4mm. took place. With the exception of the preceding, and the distances of the dorsal fins, anus, and anal spine from the snout—viz., *d* 1 D, *d* 2 D, *d* A, and *d* As—none of the differences exceed 2·5mm. In the case of *d* 1 D and *d* 2 D, the greatest differences are 3·5 and 3mm. respectively. In *d* A the difference is as large as 5·5mm., and so with *d* As. The latter is the greatest dimension measured on the fish. Those fishes which show the extreme differences—*e.g.*, Nos. 2, 5, and 6—in this character, also show considerable differences in other characters. Again, it is remarkable that, even although the fish itself has shrunk in length 1 per cent.—*e.g.*, No. 1—the measurement *d* As. remains at 23·5cm., which it was found to be before freezing. If that measurement had decreased in the same proportion as the total length had lessened, its size should have been 23·3. The fish was no doubt contorted when it was in a fresh condition; and the disarrangement of its parts may, through its being frozen, have been lessened or increased. It is at least evident that in the varied treatment which a fish may receive in capture, or in packing, an amount of contortion may occur which it is quite impossible to measure or eliminate. This, then, militates against the accuracy of the body-measurements, and must be kept in view in the discussion of the results. The error due to the personal equation of the observer is eliminated in a large series of measurements, when the characters themselves permit of accurate measurement. In the case of enumeration of vertebræ and fin-rays, where the numbers are small, as in the mackerel, the personal error may be left out of consideration.

It was further found that very often the measurements of certain characters were of different values for the two sides of the fish. Thus, for example, in 14 mackerel, measuring from 31–36cm., the greatest difference between the lengths of the mandibles of the right and left sides was 1mm. The most common difference was ·5mm. In the case of the dentary, measured on both sides in 15 specimens, in nine cases equality was found, in one case the difference was 1mm., while in the others it was ·5mm. The length of the pectoral fin was found to be the same on both sides in three out of six fish measuring from 34–36cm.; in two there was a difference of 1mm., and in the sixth a difference of ·5mm. As regards the length of snout, the greatest difference was 1mm.; this occurred in two specimens. In the lateral length of the head, a difference of 1mm. was found; but this was not exceeded. The distance of the pectoral fin from the snout varied as much as 2·5mm. on the two sides; while in the distance of the ventral fin differences of ·5mm. (three specimens), 1mm. (one specimen), 1·5mm. (one specimen), 4mm. (one specimen).

In this research all the measurements have been made on the left side of the fish.

Vertebræ and Fin-rays.

In the enumeration of the vertebræ no difficulty presents itself; the same is true of the fin-rays, with the exception of those of the first dorsal fin. The posterior rays of this fin are, as Garstang has pointed out, very small, and often do not appear above the skin. It is necessary to dissect the floor of the dorsal groove in every fish ere one can be sure that all the fin-rays have been noticed. In many cases only the base is found as the representative of the ray. This, however, has been included in the number of rays.

The Mackerel Investigated.

The mackerel were obtained from three localities:—

I. Clyde—Lower Loch Fyne,	June and July	1899—	171	fishes	183
„ Kilbrennan Sound,	October 9th	„	12	„	
II. Barra	June	„	65	„	88
Stornoway	August 13th	„	23	„	
III. Aberdeen	August and September,				207

The mackerel from Lower Loch Fyne were taken in mackerel nets; those procured from the other districts were captured in herring drift-nets.

The following Table (II.) shows the sizes and numbers of the fish examined. They have been arranged in centimetre divisions. All the fishes, for example, measuring from 30 to 30·9cm. are entered in the 30cm. group, and similarly with the others.

Table II.—Sizes and Sex of the Mackerel Examined.

Size.		Aberdeen.		Clyde.			Barra and Stornoway.		
Inches (approximate).	Cm.	♂	♀	♂	♀	?	♂	♀	?
10	26	.	.	.	.			1	.
	27	.	.	.	1		1	.	2
11	28	.	.	3	3	2	1	.	1
	29	1	1	5	3	.	1	1	1
12	30	3	.	5	.	.	6	3	3
	31	11	5	3	5	.	3	4	.
	32	21	15	9	12	.	1	10	3
13	33	32	32	10	6	.	2	4	1
	34	31	19	22	16	.	1	2	.
14	35	8	20	17	25	.	1	.	.
	36	2	2	11	12	.	.	.	.
	37	3	1	4	1	.	1	2	.
15	38	.	.	2	4	.	2	2	.
	39	.	.	.	2	.	1	4	.
16	40	.	.	.	.	.	1	4	.
	41	.	.	.	.	.	2	1	.
	42	.	.	.	.	.	1	2	.
17	43	.	.	.	.	.	.	2	.
Total, - -		112	95	91	90	2	35	42	11

TABLE IIA.—AVERAGE SIZES OF THE MACKEREL OF THE THREE DISTRICTS.

	Sex.	No.	Average Size. Cm.	♂ No.	♂ Average Size. Cm.	♀ No.	♀ Average Size. Cm.	Total. No.	Total. Average Size. Cm.
Aberdeen,	♂	112	33	207	33·2				
	♀	95	33·4						
Clyde,	♂	91	33·5	183*	33·6			478	33.4
	♀	90	34						
Barra and Stornoway,	♂	35	33	88*	33·6				
	♀	42	35						

* Mackerel of undetermined sex included.

It will be noticed that the fishes are grouped mainly about the sizes 32-35cm., the numbers tapering off above and below these limits. On reference to Table IIA., which gives the average size of the fishes from each district, it will be seen that their averages range from 33-35cm., a space of less than one inch. In instituting a comparison between the characters of two or more groups of fishes, it is necessary that they be as near as possible of the same stage, which is conveniently determined by their size. This is important in order to eliminate variations which may be due to growth. All the mackerel here recorded, with three exceptions, are of mature size; that is to say, their sizes do not fall below the sizes of the smallest mature forms. The smallest mackerel was an unripe female of a length of 26·8cm. The smallest ripe male was 27·7cm. Two unripe specimens of 27 and 27·5 were obtained from Barra. Their sex was not determined. The smallest ripe female was 28·9cm.; a male of this size was also ripe. The smallest ripe female observed by Cunningham* was 29·5cm., while the smallet ripe male was 30·3cm. He considered a mackerel of that size to be two years old.

In a total of 236 mackerel obtained from Loch Fyne and Barra, measuring from 26-43cm., only 13 examples were not ripe; four females, measuring 26·8, 28·4, 30, and 32·3cm., were unripe; four specimens of 27, 27·5, 28·5, and 28·6cm. (sex undetermined) were unripe; five males of from 32-37cm. were not ripe, but may have been spent. It is thus evident that the mackerel examined were of mature size. None of the Aberdeen mackerel were less than 29·4cm., and the fish at this size, a female, was spent. One specimen from Kilbrennan Sound was 27·6cm., and the ovary had the appearance of being spent. It is, then, obvious that a fair comparison may be drawn between the groups, so far as the stage of development is concerned.

There is still sex-variability, which Heincke, however, found to be of very little moment in the herring. I have, however, kept the averages of the males and the females separate. When combining them to get the average for the group I have included those mackerel which appear in the Tables as of undetermined sex.

* *Journal Marine Biological Association*, N.S. Vol. II., p. 232.

Conversion of Measurements into Percentages.

In order to admit of a comparison between the measurements made upon mackerel of different sizes, it is necessary to convert them into percentages of some standard length. The total length of the fish is a convenient standard, in percentages of which the measurements may be expressed. I have adopted that standard. Heincke, however, employed for the herring more than one standard. For measurements made upon the head he took for his standard the length of the head, and so on. This may, or may not, be an advantage, but for the sake of simplicity I have employed only one standard.

Means or Averages.

The averages of all the characters were then calculated for all the individuals in each of the one-centimetre divisions. The averages for the males and females are to be found in Table VII. (Aberdeen), IX. (Clyde), and VIII. (Barra), (pp. 315 *et seq.*). The figure within brackets, alongside each average, indicates the number of individuals from which the average was calculated. The averages of all the males and all the females in respect to each character were then found (Table III.), and this was finally done for the males and females together (*vide* Tables IV. and IVa). The figures in the vertical columns marked (No.) give the number of individuals from which the average was made. The Standard Deviation (σ) and Fluctuation of the Mean ($M \pm 5r$) is given for several characters in Table VIIa. In the calculation of these quantities I am indebted to Mr. H. M. Kyle for much assistance.

TABLE III.

Average Percentages (M) for the Male and Female Mackerel of each Locality.

	Sex.	*G.* Pect.		*G.* 2nd D.		*G.* Tail.		D. Groove.		*l* Pf.		*l* Sn.		*ll* H.		*d* Pf.		*d* Vf.	
		No.	M.	No.	M.	No.	M.	No.	M.	No.	M.	No.	M.	No.	M.	No.	M.	No.	M.
Aberdeen.	♂	*43*	41·9	*41*	40·07	*45*	8·73	*104*	15·05	*100*	11·01	*79*	9·09	*82*	22·57	*89*	23·99	*28*	27·67
	♀	*33*	41·07	*29*	39·18	*31*	8·49	*74*	15·06	*76*	10·98	*59*	9·07	*59*	22·59	*60*	23·88	*28*	27·67
Clyde.	♂	*49*	41·25	*72*	39·92	*71*	8·75	*57*	15·44	*66*	11·26	*67*	9·07	*77*	22·04	*81*	23·37	*58*	26·89
	♀	*37*	41·75	*50*	40·15	*50*	8·72	*46*	15·59	*53*	11·25	*51*	9·03	*69*	22·13	*70*	23·48	*46*	26·93
Barra and Stornoway.	♂	*28*	40·68	*27*	38·75	*28*	8·89	*27*	15·18	*28*	11·03	*28*	9·02	*27*	22·14	*28*	23·49	*25*	27·02
	♀	*37*	40·18	*37*	37·77	*37*	8·74	*38*	15·14	*38*	11·04	*37*	8·97	*38*	22·11	*38*	23·33	*35*	27·19
	?	*6*	39·86	*6*	38·98	*6*	8·56	*6*	14·93	*6*	10·65	*6*	9·51	*6*	23·03	*6*	24·38	*3*	26·4

TABLE III.—*continued.*

	Sex.	*d* 1 D.		*d* 2 D.		*d* A.		*d* As.		*l* Sk.		*l* M.		*l* De.		*l* T.		*l* Cr.	
		No.	M.	No.	M.	No.	M.	No.	M.	No.	M.	No.	M.	No.	M.	No.	M.	No.	M.
Aberdeen.	♂	*90*	30·56	*68*	63·25	*32*	63·62	*74*	64·41	*103*	16·42	*103*	12·68	*109*	7·61	*105*	7·67	*91*	18·61
	♀	*66*	30·59	*64*	63·43	*31*	63·72	*58*	64·49	*91*	16·38	*87*	12·60	*94*	7·59	*88*	7·55	*83*	18·54
Clyde.	♂	*82*	30·23	*82*	62·92	*67*	63·48	*81*	64·38	*77*	16·25	*68*	12·58	*69*	7·55	*56*	7·60	*45*	18·46
	♀	*71*	30·30	*70*	62·92	*53*	63·68	*69*	64·59	*79*	16·14	*61*	12·53	*65*	7·51	*47*	7·64	*44*	18·22
Barra and Stornoway.	♂	*28*	30·23	*28*	63·59	*26*	64·18	*28*	64·92	*30*	16·12	*32*	12·55	*32*	7·61	*35*	7·61	*35*	18·27
	♀	*38*	30·31	*38*	63·47	*37*	64·24	*38*	65·02	*39*	16·11	*39*	12·44	*39*	7·52	*38*	7·48	*39*	18·29
	?	*6*	30·51	*6*	63·20	*3*	65·23	*6*	65·31	*7*	16·38	*8*	12·80	*8*	7·71	*7*	7·61	*7*	17·95

Table IV.

Average Percentages for the Two Sexes combined.

	Both Sexes.	*G.* Pect.		*G.* 2nd D.		*G.* Tail.		D. Groove.		*d* Pf.		*d* Vf.		*d* A.		*l* Cr.	
		No.	M.	No.	M.	No.	M.	No.	M.	No.	M.	No.	M.	No.	M.	No.	M.
Aberdeen.	,,	*76*	41·68	*70*	39·7	*76*	8·63	*178*	15·06	*149*	23·94	*56*	27·67	*63*	63·67	*174*	18·57
Clyde.	,,	*88*	41·42	*124*	40	*123*	8·72	*105*	15·49	*153*	23·43	*106*	26·9	*122*	63·56	*91*	18·34
Barra and Stornoway.	,,	*71*	40·35	*70*	38·2	*71*	8·78	*71*	15·14	*72*	23·47	*63*	27·05	*66*	64·26	*81*	18·26

Table IVa.

Means, Standard Deviations, Fluctuations of the Means of certain Characters for the Two Sexes combined.

	l Pf.				*l* Sn.				*H* H.				*d* 1 D.				*d* 2 D.			
	No.	M	σ	M ± 5r.	No.	M	σ	M ± 5r.	No.	M	σ	M ± 5r.	No.	M	σ	M ± 5r.	No.	M	σ	M ± 5r.
Aberdeen.	*176*	10·99	·14	10·94 – 11·07	*138*	9·08	·107	9·05 – 9·11	*141*	22·57	·2	22·51 – 22·62	*146*	30·57	·21	30·51 – 30·62	*153*	63·31	·29	63·23 – 63·39
Clyde.	*120*	11·26	·21	11·19 – 11·32	*120*	9·06	·19	9·00 – 9·12	*148*	22·08	·6	21·91 – 22·24	*155*	30·25	·29	30·17 – 30·33	*155*	62·91	·49	62·78 – 63·04
Barra & Stornoway.	*72*	11·00	·32	10·87 – 11·12	*71*	9·03	·31	8·91 – 9·16	*71*	22·18	·58	21·95 – 22·41	*72*	30·30	·42	30·13 – 30·47	*72*	63·48	·5	63·27 – 63·69
	d As.				*l* Sk.				*l* M.				*l* De.				T.			
	No.	M	σ	M ± 5r.	No.	M	σ	M ± 5r.	No.	M	σ	M ± 5r.	No.	M	σ	M ± 5r.	No.	M	σ	M ± 5r
Aberdeen.	*132*	64·44	·22	64·37 – 64·50	*194*	16·40	·109	16·37 – 16·42	*195*	12·64	·11	12·61 – 15·66	*203*	7·60	·06	7·58 – 7·61	*191*	7·62	·12	7·59 – 7·65
Clyde.	*152*	64·47	·3	64·38 – 64·55	*157*	16·20	·26	16·13 – 16·27	*131*	12·56	·19	12·50 – 12·61	*136*	7·54	·13	7·50 – 7·56	*106*	7·62	·13	7·57 – 7·65
Barra & Stornoway.	*72*	65·01	·58	64·77 – 65·24	*76*	16·13	·32	16·01 – 16·26	*79*	12·52	·28	12·42 – 12·62	*79*	7·56	·167	7·50 – 7·62	*80*	7·54	·2	7·47 – 7·62

TABLE V.

The Mean Number of Rays in the First and Second Dorsal and Anal Fins, and of the Dorsal and Anal Finlets.

District.	Sex.	First Dorsal.		Second Dorsal.		Dorsal Finlets.		Anal Fin.		Anal Finlets.	
		No.	M.	No.	M.	No.	M.	No.	M.	No.	M.
Aberdeen.	♂	*111*	13·54	*112*	11·99	*111*	5	*112*	11·92	*112*	5
		93	13·45	*95*	11·91	*95*	4·99	*95*	11·92	*95*	5·01
Clyde.	♂	*90*	13·4	*91*	11·92	*91*	4·99	*90*	11·90	*91*	5
	♀	*89*	13·37	*89*	11·95	*90*	5·01	*89*	11·81	*90*	5·01
Barra and Stornoway.	♂	*34*	13·77	*33*	11·94	*35*	4·94	*35*	11·94	*35*	4·97
	♀	*42*	13·72	*42*	11·89	*42*	5	*42*	11·95	*42*	5·02
	?	*11*	13·36	*11*	11·91	*11*	4·91	*11*	12·09	*11*	5

Table Va.

The Means, Standard Deviations, and Fluctuations of the Means of the Numbers of Fin-rays and Finlets.

	Sex.	First Dorsal.				Second Dorsal.				Dorsal Finlets.				Anal.				Anal Finlets.			
		No.	M	σ	M ± 5r.	No.	M.	σ	M ± 5r.	No.	M	σ	M ± 5r.	No.	M	σ	M ± 5r.	No.	M	σ	M ± 5r.
Aberdeen.	♂+♀	*204*	13·50	1·01	13·27 – 13·73	*207*	11·95	·4	11·86 – 12·04	*206*	4·996	·18	4·95 – 5·03	*207*	11·92	·44	11·82 – 12·02	*207*	5·004	·18	4·96 – 5·04
Clyde.	♂+♀	*181*	13·40	1·06	13·14 – 13·66	*182*	11·92	·43	11·82 – 12·02	*183*	5	·14	4·96 – 5·03	*181*	11·86	·43	11·76 – 11·96	*183*	5·005	·22	4·95 – 5·05
Barra, &c.	♂÷♀	*87*	13·76	·97	13·41 – 14·11	*86*	11·91	·32	11·80 – 12·02	*88*	4·96	·18	4·90 – 5·03	*88*	11·96	·38	11·8 – 12·07	*88*	5	·15	4·95 – 5·05

TABLE VI.

Dimensions (in centimetres) of a Theoretical Mackerel, 33cm. (13 inches) in length, deduced from the Average Percentages for each District.

	Girth.			D. Groove.	*l* Pf.	*l* Sn.	*ll* H.	*d* Pf.	*d* Vf.	*d* 1 D.	*d* 2 D.	*d* A.	*d* As.	*l* Sk.	*l* M.	*l* De.	*l* T.	*l* Cr.
	Pect.	2nd D.	T.															
Aberdeen.	13·76	13·1	2·84	4·98	3 63	2·99	7·45	7·88	9·14	10·09	20·89	21·02	21·25	5·41	4·16	2·50	2·51	6·14
Clyde.	13·66	13·2	2·87	5·11	3·72	2·98	7·29	7·72	8·87	9·96	20·75	20·98	21·28	5·34	4·16	2·48	2·51	6·03
Barra and Stornoway.	13·3	12·6	2·89	4·98	3·63	2·97	7·32	7·75	8·91	9·99	20·95	21·18	21·45	5·31	4·12	2·49	2·48	6·03

Fin-rays and Finlets.

The variations in the numbers of fin-rays and finlets are given in Table IXA. (p. 319). The average number of fin-rays in the first and second dorsal and anal fins was calculated for males and females separately (Table V.), and for the two sexes combined (Table VA). The same was done for the dorsal and anal finlets, and the results are given with the former. Owing to the fact that the majority of the mackerel from each locality are of nearly one size, it is impossible to satisfactorily break them up into groups by which any change in the number of fin-rays due to growth might be proved to be present or not. So far as sexual differences are concerned, Table V. does not give any proof of their existence. The only difference between the averages of the males and females is to be found in the second place of decimals. This holds good for each fin, and for the finlets in the mackerel from the three localities. Eleven of the Stornoway specimens, of undetermined sex, give a slightly different average for the rays of the first dorsal, but in so variable a character eleven specimens are too few upon which to place any importance. If, now, the males and females are taken together, and a comparison made between the Means for the three localities, a little divergence is seen in the case of the first dorsal fin. In respect to this character the Means for Aberdeen, the Clyde, and Barra and Stornoway are respectively 13·5, 13·4, and 13·76. In place of comparing the observed averages, it is necessary to compare the fluctuations of the Means (Table VA.). In the case of the first dorsal the fluctuation is 13·27–13·73 for Aberdeen, that for the Clyde 13·14–13·66, and that for Barra and Stornoway 13·41–14·11. In order that the Means may be regarded as differing from one another, their fluctuations must not overlap. But in this case all three do so, so that the probability is that as regards this character there is no racial distinction between the mackerel of the three districts. On reference to the Table it is seen that the fluctuations of the Means overlap in the case of the rays of the second dorsal and anal fins and the finlets. So far, then, as these characters are concerned, no racial differences exist between the three groups.

Vertebræ.

The number of vertebræ was found to be very constant, viz., 31. One mackerel alone, 31·3cm. in length, from the Clyde, had a greater number, viz., 32. No example was found with less than 31 vertebræ.

The Question of Sexual Differences.

So far as this research goes, none of the characters examined can be claimed to have any sexual variability. On reference to Table III. it may be seen that the relation between the male and female averages is comparatively irregular. While in one group of mackerel (Aberdeen) the male average for the distance of the origin of the pectoral fin from the snout (*d* Pf.) is greater than the female average, in the Clyde the reverse is the case, and in the Barra fishes the male average is again the greater. In three characters only—the distance of the first dorsal (*d* 1 D), the distance of the anus (*d* A), and the distance of the anal spine (*d* As) from the snout respectively—is the female average greater than that of the male in the mackerel from all three localities. The male average, on the other hand, exceeds the female in three characters—viz., the length of the skull (*l* Sk), the length of the mandible (*l* M), and the length of

the dentary (*l* De). These six characters are alone those in which any sexual distinction appears. In the distance of the first dorsal from the snout (*d* 1 D) the female average exceeds the male in the Aberdeen lot by ·03, in the Clyde group by ·07, and in those from Barra and Stornoway by ·08. In the distance of the anus from the snout (*d* A) the female exceeds the male average by ·1 for Aberdeen, ·2 for the Clyde, and by ·06 for Barra; and in the distance of the anal spine from the snout (*d* As) the differences are—Aberdeen ·08, Clyde ·18, Barra ·06. The greatest difference between the averages is in the case of the distance of the anus from the snout (*d* A) in the Clyde fish, in which case it is ·2. It is, however, necessary to apply to these differences the test of probability. The averages are not really different unless their fluctuations fail to overlap. Now, in the case where there is the largest difference (·2) just cited, the averages are—female 63·68, male 63·48. The male average has a fluctuation of from 63·3–63·64, which approaches the female average so closely that its fluctuation must necessarily overlap that of the former. So with the other differences; none of them are sufficiently large to warrant the averages being regarded as indicating sexual differences. Again, the male average exceeds that of the female in the length of the skull (*l* Sk), length of the mandible (*l* M), and length of the dentary (*l* De). The greatest difference does not exceed ·15—a difference which is not sufficient to prevent the overlapping of their fluctuations. The conclusion is, then, warranted that of the characters treated none are of sexual variability.

Comparison of the Mackerel from the Three Districts.

The group average by which the three lots of mackerel are to be compared is the average of the males and females combined. This combined average is given for each character in Tables IV. and IVA. The fluctuation of the average has been calculated for certain of the characters which were capable of more exact measurement than the others (Table IVA). So far as the characters in Table IV. are concerned, the averages of the three groups approach each other very closely, and, allowing for the fact that the dimensions are not capable of very exact measurement, they may be regarded as practically coinciding. In the following characters—then, girth at three points,, viz., in pectoral region, at beginning of second dorsal fin, and at the root of the tail, the lengths of the dorsal groove and of the superior ramus of the tail fin, the positions of the pectoral and ventral fins and of the anus—the mackerel from Aberdeen, the Clyde, and Barra and Stornoway show no appreciable difference.

On examination of Table IVA. a very close agreement is seen to exist between the three localities in respect to the characters there entered. In this case the greater or less resemblance will be tested by the fluctuations of the Means of the dimensions. In these characters, the means of which for the three localities overlap through their fluctuations, viz., the length of the snout (*l* Sn), the length of the mandible (l M), the length of the dentary (*l* De), and the length of the tail (*l* T), complete agreement is demonstrated. They do not, so far as the evidence in this paper goes, afford any indication of racial differences between the mackerel of the three localities. In the remaining characters, viz., the length of the pectoral fin (*l* Pf), the distance of the first dorsal fin (*d* 1 D), the distance of the second dorsal fin (*d* 2 D), distance of the anal spine (*d* As) from the snout respectively, the length of the skull (*l* Sk), the three Means do not overlap, but in each character the Means for two localities do so. Thus, for example, the Clyde and

Barra mackerel overlap in respect to the fluctuations of the Means of the characters, lateral length of the head (*ll* H), distance of the first dorsal fin (*d* 1 D), and length of the skull (*l* Sk); while the Aberdeen and Barra specimens overlap in the length of the pectoral fin (*l* Pf) and distance of the second dorsal fin (*d* 2 D).

The liability of the distances of the first and second dorsal fins (*d* 1 D and *d* 2 D) to alteration through the contortion of the fish has been already referred to, and it may be well not to press the agreements and differences in these characters. Leaving these characters aside, the evidence points to the conclusion that in the lateral length of the head and the length of the skull it is probable that the mackerel of the Clyde and those of Barra and Stornoway resemble each other more closely than they do those of Aberdeen; while, as regards the length of the pectoral fin, Aberdeen and Barra and Stornoway mackerel would appear to be more closely allied to one another than they are to the mackerel of the Clyde. The nature of the relationship consists in the Clyde and Barra mackerel having a slightly shorter skull and lateral length of head than the Aberdeen forms; the means of these dimensions in the case of the fishes of the former districts lie between 16·01 and 16·27, and between 21·91 and 22·41, while the fluctuations of the means for the Aberdeen district are 16·37–16·42, and 22·51–22·62 respectively. In the Clyde specimens the pectoral fin is found to be slightly longer than in the Barra and Aberdeen examples. The means for this character lie between 10·87 and 11·07 in the Aberdeen and Barra specimens, and between 11·19 and 11·32 in the Clyde fishes.

In order to show how great the differences between the groups are in respect to the dimensions of the selected characters, and to the number of fin-rays and finlets, a typical mackerel has been constructed for each district from the average percentages given above. The averages for the males and females combined are used. The average length of all the mackerel is 33·4cm. The dimensions of a theoretical mackerel of a length of 33cm. (13 inches) are given in Table VI. All the dimensions are in centimetres, and it is therefore possible to see exactly by how much the averages are separated from one another.

Conclusion.

Of the varied characters which have been considered, there are, with the three exceptions referred to above, probably none which differ in the three groups to an extent that would permit stress to be laid upon them, when the shortcomings of the dimensions in respect to accurate measurement are taken into account. In the case of the fin-rays, finlets, and vertebræ, no differences which would on Heincke's method admit of their separation into races were found. Between the mackerel, then, which were caught at the times recorded in the Clyde, at Barra and Stornoway, and off Aberdeen, the differences in the lengths of the head, skull, and pectoral fin may with some probability be granted racial distinction. The shorter length of head and skull, in which the Clyde and Barra and Stornoway lots more closely resemble one another, separate them slightly from the Aberdeen collection. And in respect to a shorter pectoral fin the Aberdeen and Barra and Stornoway fish are separated by a small interval from the Clyde individuals. With regard to the remaining characters I consider that the evidence does not prove them of racial distinction.

Table VII.—Aberdeen.

Average Dimensions in Percentage of Total Length of Mackerel.

Length—cm.	Sex.	Girth.			Dorsal Groove.	*l* Pf.	*l* Sn.	*U* H.	*d* Pf.	*d* Vf.	*d* 1 D.	*d* 2 D.	*d* A.	*d* As.	*l* Sk.	*l* M.	*l* De.	*l* T.	*l* Cr.
		Pect.	2nd D.	Tail.															
29—29·9	♂	.	.	.	15·0 (1)	11·7 (1)	.	.	24·7 (1)	.	31·4 (1)	63·8 (2)	.	64·1 (1)	16·7 (1)	13·0 (1)	7·8 (1)	8·0 (1)	18·4 (1)
,,	♀	.	.	.	.	.	.	.	.	.	.	.	.	.	16·4 (1)	12·3 (1)	7·3 (1)	.	.
30—30·9	♂	41·9 (2)	40·3 (2)	8·8 (2)	14·4 (3)	11·3 (3)	9·2 (3)	23·0 (3)	24·3 (3)	27·6 (2)	30·8 (3)	63·2 (2)	64·2 (2)	64·8 (2)	16·8 (2)	12·9 (3)	7·7 (3)	7·8 (3)	18·7 (3)
31—31·9	♂	41·0 (3)	39·5 (3)	8·8 (3)	14·6 (11)	10·9 (11)	9·0 (6)	22·0 (5)	23·5 (7)	27·7 (2)	30·4 (7)	62·9 (7)	63·1 (2)	64·0 (5)	16·5 (10)	12·8 (1)	7·6 (11)	7·7 (11)	18·3 (9)
,,	♀	41·5 (2)	39·4 (1)	8·3 (2)	14·3 (3)	11·4 (4)	9·3 (4)	22·9 (4)	24·2 (4)	28·3 (1)	30·6 (4)	63·4 (4)	62·6 (1)	64·0 (3)	16·6 (3)	12·9 (4)	7·8 (5)	7·7 (5)	18·5 (4)
32—32·9	♂	41·7 (7)	39·7 (7)	8·6 (7)	15·0 (19)	11·0 (17)	9·2 (13)	22·7 (14)	24·6 (14)	27·9 (3)	30·4 (14)	62·8 (13)	63·0 (4)	64·1 (13)	16·5 (20)	12·7 (20)	7·6 (21)	7·7 (19)	18·7 (18)
,,	♀	40·1 (1)	38·0 (1)	8·5 (1)	15·1 (9)	10·0 (7)	9·2 (4)	22·4 (5)	24·6 (5)	28·6 (1)	30·6 (6)	63·3 (4)	62·6 (1)	63·9 (4)	16·5 (14)	12·8 (14)	7·7 (14)	7·7 (12)	18·7 (11)
33—33·9	♂	42·5 (16)	40·3 (16)	8·7 (16)	15·1 (28)	11·1 (28)	9·1 (26)	22·5 (25)	23·8 (27)	27·9 (7)	30·6 (27)	63·1 (27)	63·8 (11)	64·4 (22)	16·4 (30)	12·6 (29)	7·6 (31)	7·7 (31)	18·6 (27)
,,	♀	41·8 (10)	39·4 (10)	8·6 (9)	15·3 (25)	11·1 (26)	9·1 (23)	22·7 (20)	23·9 (22)	27·8 (8)	30·6 (24)	63·3 (24)	63·4 (10)	64·3 (21)	16·4 (32)	12·6 (30)	7·6 (32)	7·6 (30)	18·6 (28)
34—34·9	♂	41·6 (8)	39·3 (7)	8·8 (10)	15·3 (30)	11·1 (28)	9·1 (22)	22·7 (25)	24·0 (25)	27·6 (9)	30·6 (26)	63·5 (26)	63·6 (7)	64·4 (21)	16·4 (28)	12·7 (31)	·6 (30)	7·6 (29)	18·6 (26)
,,	♀	40·7 (7)	37·5 (6)	8·4 (7)	15·0 (16)	10·9 (17)	9·1 (12)	22·5 (12)	24·0 (11)	27·6 (5)	30·7 (14)	63·8 (14)	64·1 (6)	64·9 (14)	16·3 (19)	12·5 (18)	7·6 (19)	7·3 (18)	18·4 (17)
35—35·9	♂	41·9 (2)	40·3 (2)	8·5 (2)	15·0 (7)	10·9 (7)	8·9 (4)	22·3 (5)	23·9 (7)	26·8 (1)	30·4 (7)	63·2 (7)	63·7 (2)	64·1 (5)	16·2 (7)	12·6 (8)	7·6 (7)	7·7 (6)	19·0 (4)
,,	♀	41·4 (12)	39·8 (10)	8·5 (1)	15·0 (19)	10·9 (19)	8·9 (15)	22·5 (16)	23·6 (16)	27·6 (11)	30·5 (16)	63·3 (16)	64 (11)	64·6 (14)	16·3 (19)	12·5 (17)	7·5 (20)	7·6 (20)	18·5 (20)
36—36·9	♂	41·7 (2)	38·4 (1)	8·9 (2)	15·0 (2)	10·4 (2)	9·0 (2)	22·6 (2)	24·2 (2)	27·0 (2)	31·4 (2)	64·1 (2)	65·4 (1)	65·6 (2)	16·6 (2)	12·6 (2)	7·7 (2)	7·6 (2)	18·8 (2)
,,	♀	42·8 (1)	42·5 (1)	8·5 (1)	13·8 (1)	10·9 (2)	8·5 (1)	21·4 (1)	22·1 (1)	26·6 (1)	29·2 (1)	64·3 (1)	63·7 (1)	64·9 (1)	15·9 (2)	12·5 (2)	7·5 (2)	7·4 (2)	18·5 (2)
37—37·9	♂	42·6 (3)	42·5 (3)	9·0 (3)	15·4 (3)	11·1 (3)	8·9 (3)	22·5 (3)	23·5 (3)	28·1 (2)	30·2 (3)	63·7 (2)	63·2 (3)	64·0 (3)	16·2 (3)	12·7 (3)	7·8 (3)	7·7 (3)	18·5 (1)
,,	♀	.	.	.	15·0 (1)	10·6 (1)	9·1 (1)	23·0 (1)	23·9 (1)	27·4 (1)	31·7 (1)	63·6 (1)	64·1 (1)	64·9 (1)	16·5 (11)	12·7 (1)	7·6 (1)	7·5 (1)	18·6 (1)

Table VIII.—Clyde.

Average Dimensions in Percentage of Total Length of Mackerel.

Length—cm.	Sex.	Girth.			Dorsal Groove.	*l* Pf.	*l* Sn.	*ll* H.	*d* Pf.	*d* Vf.	*d* 1 D.	*d* 2 D.	*d* A.	*d* As.	*l* Sk.	*l* M.	*l* De	*l* T.	*l* Cr.
		Pect.	2nd D.	Tail.															
27—27·9	♀	41·6 (1)	42·0 (1)	8·3 (1)	14·8 (1)	10·9 (1)	8·7 (1)	22·1 (1)	23·2 (1)	27·7 (1)	29·5 (1)	63·3 (1)	62·6 (1)	63·7 (1)	16·5 (1)	12·5 (1)	7·4 (1)	.	18·5 (1)
28—28·9	♂	41·8 (3)	40·8 (3)	8·7 (3)	15·2 (3)	11·1 (3)	8·6 (3)	22·4 (2)	23·8 (3)	27·6 (2)	29·6 (3)	62·6 (3)	63·0 (3)	64·2 (3)	16·1 (1)	12·9 (3)	7·8 (3)	7·8 (3)	18·5 (2)
,,	♀	40·6 (3)	41·2 (3)	8·4 (3)	15·8 (2)	10·9 (3)	9·0 (3)	22·3 (3)	23·6 (3)	26·9 (3)	30·0 (2)	61·9 (3)	63·8 (3)	64·5 (3)	16·5 (3)	12·7 (3)	7·6 (2)	7·6 (3)	18·3 (2)
	?	*40·9 (2)*	*39·1 (2)*	*8·3 (2)*	*14·7 (2)*	*11·1 (1)*	*9·6 (2)*	*22·9 (2)*	*24·2 (2)*	*27·0 (2)*	*30·0 (2)*	*62·6 (2)*	*62·7 (2)*	*63·7 (2)*	*16·7 (1)*	*12·8 (2)*	*7·6 (2)*	*7·6 (2)*	*17·6 (2)*
29—29·9	♂	41·0 (4)	40·3 (5)	8·8 (5)	14·5 (5)	11·2 (5)	9·2 (5)	22·2 (5)	23·4 (5)	26·4 (4)	30·4 (5)	62·1 (5)	62·8 (5)	63·8 (5)	16·6 (4)	12·9 (5)	7·7 (5)	7·6 (4)	17·8 (4)
,,	♀	41·8 (3)	40·2 (3)	8·6 (3)	15·3 (3)	11·1 (3)	9·1 (3)	22·8 (3)	24·2 (2)	28·2 (2)	30·0 (3)	62·9 (3)	62·6 (3)	63·6 (3)	16·8 (3)	13·0 (3)	7·8 (3)	7·7 (3)	18·1 (3)
30—30·9	♂	41·8 (2)	40·7 (5)	8·6 (4)	15·3 (2)	11·4 (4)	9·3 (5)	22·3 (4)	23·5 (5)	27·3 (3)	30·4 (5)	63·0 (5)	63·3 (4)	64·5 (4)	16·3 (4)	12·4 (3)	7·6 (2)	7·8 (2)	17·9 (2)
31—31·9	♂	41·0 (1)	40·0 (2)	8·7 (2)	14·9 (1)	11·8 (2)	9·6 (2)	22·1 (3)	23·3 (3)	27·5 (2)	31·0 (3)	62·8 (3)	63·2 (2)	64·6 (3)	16·2 (3)	12·6 (2)	7·8 (1)	7·1 (1)	17·6 (1)
,,	♀	43·2 (2)	39·8 (3)	8·7 (3)	14·5 (3)	11·0 (3)	9·2 (3)	22·2 (4)	23·5 (4)	26·7 (3)	30·2 (4)	62·7 (4)	63·4 (3)	64·9 (4)	16·4 (5)	12·8 (4)	7·7 (4)	7·3 (3)	17·5 (2)
32—32·9	♂	39·7 (5)	39·0 (7)	8·7 (7)	14·8 (5)	11·4 (5)	9·2 (5)	22·1 (7)	23·6 (8)	27·3 (5)	30·3 (8)	62·7 (8)	63·0 (5)	64·0 (8)	16·8 (8)	12·8 (7)	7·7 (7)	7·5 (5)	18·7 (5)
	♀	41·5 (4)	40·2 (7)	8·9 (7)	15·4 (7)	11·5 (8)	9·3 (8)	22·2 (11)	23·7 (10)	26·9 (6)	30·2 (11)	62·6 (10)	63·5 (7)	64·2 (10)	16·2 (11)	12·6 (9)	7·5 (8)	7·7 (7)	18·2 (7)
33—33·9	♂	41·8 (5)	40·7 (9)	9·0 (9)	15·9 (7)	11·6 (8)	9·0 (8)	21·9 (9)	23·1 (9)	26·8 (7)	30·1 (9)	62·3 (9)	63·3 (8)	64·1 (9)	16·1 (9)	12·6 (9)	7·6 (9)	7·6 (8)	18·8 (6)
	♀	42·2 (3)	40·2 (3)	8·8 (3)	17·1 (4)	11·1 (5)	9·1 (3)	23·4 (4)	24·2 (5)	27·2 (1)	30·4 (5)	62·6 (5)	65·0 (3)	65·4 (5)	16·5 (5)	12·5 (5)	7·7 (4)	7·9 (3)	19·1 (3)
34—34·9	♂	41·0 (11)	38·8 (14)	8·6 (14)	15·7 (14)	11·1 (14)	9·2 (14)	22·4 (17)	23·5 (19)	26·9 (10)	30·3 (19)	63·6 (19)	63·6 (14)	64·5 (19)	16·3 (20)	12·7 (14)	7·5 (17)	7·7 (14)	18·7 (5)
,	♀	41·7 (7)	40·5 (10)	8·8 (10)	15·9 (9)	11·6 (11)	9·0 (11)	22·3 (13)	23·5 (14)	26·8 (10)	30·4 (14)	63·2 (14)	63·8 (11)	64·7 (14)	16·1 (16)	12·5 (12)	7·5 (13)	7·7 (11)	18·7 (9)
35—35·9	♂	41·2 (10)	39·5 (13)	8·7 (13)	15·1 (10)	11·2 (11)	8·9 (11)	22·4 (14)	23·5 (14)	27·1 (11)	30·4 (14)	63·4 (14)	63·9 (12)	64·7 (14)	16·2 (14)	12·4 (14)	7·5 (13)	7·5 (11)	18·5 (11)
,	♀	42·0 (9)	39·8 (10)	8·5 (10)	15·6 (9)	11·1 (10)	9·0 (9)	22·3 (15)	23·5 (16)	26·9 (10)	30·7 (16)	63·5 (16)	64·0 (11)	64·9 (14)	16·1 (18)	12·5 (14)	7·5 (16)	7·7 (8)	18·8 (8)
36—36·9	♂	41·3 (5)	40·6 (9)	8·7 (9)	15·9 (6)	11·2 (9)	9·0 (9)	20·9 (11)	23·1 (10)	26·4 (9)	29·8 (11)	63·2 (11)	63·4 (9)	64·3 (11)	15·9 (11)	12·3 (6)	7·4 (7)	7·6 (6)	18·5 (5)
	♀	42·6 (2)	40·2 (6)	8·9 (6)	15·4 (5)	11·2 (6)	8·7 (6)	20·5 (9)	22·8 (9)	26·6 (6)	29·8 (9)	62·8 (8)	63·4 (7)	64·2 (9)	15·6 (11)	12·2 (6)	7·3 (9)	7·4 (5)	16·5 (5)
37—37·9	♂	42·4 (2)	40·6 (3)	9·1 (3)	16·7 (3)	11·1 (3)	8·9 (3)	21·6 (3)	22·6 (3)	25·9 (3)	29·9 (3)	63·0 (3)	64·3 (3)	64·9 (3)	15·8 (2)	12·2 (4)	7·4 (4)	7·7 (3)	18·2 (3)
,,	♀	.	.	.	.	.	.	22·3 (1)	23·8 (1)	.	30·5 (1)	63·4 (1)	.	65·1 (1)	16·2 (1)	.	7·4 (1)	.	.
38—38·9	♂	45·5 (1)	42·1 (2)	9·3 (2)	15·3 (1)	11·1 (2)	8·9 (2)	22·5 (2)	23·4 (2)	27·8 (2)	30·3 (2)	63·3 (2)	64·5 (2)	65·0 (2)	16·4 (1)	12·7 (1)	7·8 (1)	7·7 (1)	19·2 (1)
,,	♀	41·6 (1)	40·5 (2)	9·1 (2)	14·8 (1)	11·3 (1)	9·3 (2)	22·2 (3)	23·3 (3)	27·8 (2)	30·4 (3)	64·6 (3)	63·8 (2)	65·1 (3)	16·1 (3)	12·7 (2)	8·0 (2)	7·8 (2)	17·8 (2)
39—39·9	♀	40· (2)	37·5 (2)	8·7 (2)	15·0 (2	10·9 (2)	8·9 (2)	22·2 (2)	22·7 (2)	26·6 (2)	30·1 (2)	63·0 (2)	63·2 (2)	63·9 (2)	15·4 (2)	12·1 (2)	7·2 (2)	7·6 (2)	17·9 (2)

Table IX.—Barra and Stornoway.

Average Dimensions in Percentage of Total Length of Mackerel.

Length—cm.	Sex.	Girth.			Dorsal Groove.	*l* Pf.	*l* Sn.	*ll* H.	*d* Pf.	*d* Vt.	*d* 1 D.	*d* 2 D.	*d* A.	*d* As.	*l* Sk.	*l* M.	*l* De.	*l* T.	*l* Cr.
		Pect.	2nd D.	Tail.															
26—26·9	♀	40·2 (1)	39·1 (1)	8·5 (1)	15·8 (1)	11·5 (1)	9·9 (1)	23·8 (1)	24·5 (1)	27·7 (1)	31·2 (1)	63·2 (1)	64·0 (1)	64·7 (1)	17·3 (1)	13·2 (1)	7·8 (1)	8·2 (1)	18·2 (1)
27—27·9	♂	39·4 (1)	40·8 (1)	9·1 (1)	14·1 (1)	10·7 (1)	10·0 (1)	22 (1)	23·1 (1)	26·1 (1)	29·7 (1)	61·9 (1)	63·4 (1)	63·4 (1)	16·5 (1)	12·9 (1)	7·9 (1)	8·0 (1)	18·2 (1)
,,	?	*36·8* (2)	*38·3* (2)	*8·5* (2)	*14·1* (2)	*10·2* (2)	*9·4* (2)	*23·0* (2)	*24·5* (2)	*26·3* (2)	*30·7* (2)	*62·8* (2)	*64·6* (2)	*65·3* (2)	*16·5* (2)	.	.	*7·7* (2)	*17·6* (2)
28—28·9	♂	.	.	.	.	.	.	.	.	.	.	.	.	.	.	12·2 (1)	7·3 (1)	8·0 (1)	17·5 (1)
,,	?	*41·6* (1)	*41·6* (1)	*8·4* (1)	*15·0* (1)	*10·7* (1)	*9·8* (1)	*24·1* (1)	*25·2* (1)	*26·6* (1)	*31·1* (1)	*63·3* (1)	*66·5* (1)	*67·2* (1)	*16·8* (1)	*13·8* (1)	*7·9* (1)	*7·3* (1)	*17·5* (1)
29—29·9	♂	40·3 (1)	.	8·9 (1)	14·3 (1)	11·6 (1)	9·5 (1)	21·8 (1)	23·7 (1)	.	30·2 (1)	64·8 (1)	63·8 (1)	65·5 (1)	16·5 (1)	12·6 (1)	7·9 (1)	8·1 (1)	18·5 (1)
,,	?	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*8·0* (1)	*18·4* (1)
30—30·9	♂	40·6 (2)	38·9 (2)	9·1 (2)	15·4 (2)	11·5 (2)	9·0 (2)	22·3 (2)	23·8 (2)	27·0 (3)	30·1 (2)	63·4 (2)	63·8 (2)	64·8 (2)	16·4 (4)	12·9 (4)	7·5 (5)	7·8 (6)	18·5 (6)
.	♀	39·4 (1)	38·4 (1)	8·7 (1)	14·9 (1)	11·3 (1)	9·5 (1)	23·5 (1)	25·0 (1)	27·7 (1)	31·4 (1)	64·5 (1)	63·8 (1)	64·8 (1)	16·5 (1)	13·0 (1)	7·5 (1)	7·7 (2)	17·6 (2)
,,	?	*40·9* (2)	*38·8* (2)	*8·5* (2)	*16·3* (2)	*10·8* (2)	*9·5* (2)	*22·6* (2)	*23·8* (2)	.	*29·8* (2)	*63·2* (2)	.	*63·9* (2)	*16·0* (1)	*12·6* (3)	*7·4* (3)	*7·0* (2)	*18·2* (2)
31—31·9	♂	41·3 (2)	37·4 (2)	9·0 (2)	15·0 (2)	11·3 (2)	9·1 (2)	22·2 (2)	23·4 (2)	26·7 (2)	30·6 (2)	64 (2)	64·6 (2)	65·4 (2)	16·4 (3)	12·7 (3)	7·7 (3)	7·6 (3)	18·9 (3)
.	♀	40 (4)	37·7 (4)	8·7 (4)	14·5 (4)	11·2 (4)	9·1 (4)	22·6 (4)	23·8 (4)	27·0 (4)	30·7 (4)	63·1 (4)	63·4 (4)	64·4 (4)	16·5 (4)	12·9 (4)	7·6 (4)	7·5 (3)	18·7 (4)
32—32·9	♂	40·3 (10)	38·5 (10)	8·8 (10)	15·4 (9)	11·1 (10)	9·1 (10)	22·5 (9)	23·7 (10)	27·3 (9)	30·1 (10)	63·6 (10)	63·8 (9)	64·5 (10)	16·1 (10)	12·6 (10)	7·6 (10)	7·6 (11)	17·9 (11)
,,	♀	39·0 (8)	35·4 (8)	8·6 (8)	14·3 (9)	11·3 (9)	9·2 (8)	22·4 (9)	23·7 (9)	27·3 (8)	30·5 (9)	63·4 (9)	63·9 (8)	64·9 (9)	16·3 (10)	12·7 (10)	7·6 (10)	7·4 (9)	18·3 (9)
,,	?	*42·2* (1)	*38·1* (1)	*9·0* (1)	*13·8* (1)	*11·2* (1)	*9·5* (1)	*22·9* (1)	*24·5* (1)	.	*31·0* (1)	*63·9* (1)	.	*66·3* (1)	*16·3* (3)	*13·0* (3)	*7·9* (3)	.	.
33—33·9	♂	39·1 (2)	35·4 (2)	9·1 (2)	15·9 (2)	11·6 (2)	9·0 (2)	22·4 (2)	23·2 (2)	27·7 (2)	30·8 (2)	64·0 (2)	64·6 (2)	65·5 (2)	16·2 (2)	12·7 (2)	7·7 (2)	7·5 (2)	19·1 (2)
,,	♀	38·9 (4)	37·0 (4)	8·6 (4)	15·1 (4)	10·9 (4)	9·0 (4)	22·2 (4)	23·6 (4)	27·0 (4)	30·1 (4)	63·1 (4)	63·8 (4)	64·8 (4)	16·2 (4)	12·4 (4)	7·4 (4)	7·5 (4)	18·2 (4)
,,	?	.	.	.	.	.	.	.	.	.	.	.	.	.	*16·2* (1)	*13·8* (1)	*7·9* (1)	*7·4* (1)	*18·2* (1)

TABLE IX.—BARRA AND STORNOWAY—*continued.*

Length—cm.	Sex.	Girth.			Dorsal Groove.	*l* Pf.	*l* Sn.	*ll* H.	*d* Pf.	*d* Vf.	*d* 1 D.	*d* 2 D.	*d* A.	*d* As.	*l* Sk.	*l* M.	*l* De.	*l* T.	*l* Cr.
		Pect.	2nd D.	Tail.															
34—34·9	♂	41·2 (1)	38·8 (1)	8·8 (1)	14·6 (1)	10·5 (1)	8·9 (1)	22·2 (1)	23·9 (1)	.	30·1 (1)	61·9 (1)	.	63·6 (1)	.	12·5 (1)	7·7 (1)	7·7 (1)	18·7 (1)
,,	♀	40·6 (2)	38·1 (2)	8·5 (2)	15·3 (2)	11·2 (2)	9·0 (2)	23·0 (2)	24·4 (2)	28·1 (2)	30·9 (2)	63·1 (2)	64·5 (2)	65·1 (2)	16·6 (2)	12·6 (2)	7·7 (2)	7·6 (2)	18·4 (2)
35—35·9	♂	39·2 (1)	40·3 (1)	8·2 (1)	14·3 (1)	10·7 (1)	8·7 (1)	22·0 (1)	23·3 (1)	27·5 (1)	30·3 (1)	62·3 (1)	65·3 (1)	65·9 (1)	15·8 (1)	12·2 (1)	7·5 (1)	7·6 (1)	17·9 (1)
37—37·9	♂	43·1 (1)	41·8 (1)	8·7 (1)	16·5 (1)	11·0 (1)	8·8 (1)	21·0 (1)	22·1 (1)	25·5 (1)	29·2 (1)	63·5 (1)	65·4 (1)	65·9 (1)	15·8 (1)	12·2 (1)	7·2 (1)	7·9 (1)	18·8 (1)
,,	♀	39·5 (2)	37·9 (2)	8·6 (2)	15·2 (2)	10·8 (2)	9·1 (2)	21·7 (2)	23·3 (2)	26·2 (2)	30·0 (2)	63·4 (2)	64·0 (2)	64·6 (2)	15·9 (2)	11·8 (1)	7·3 (2)	7·6 (2)	19·0 (2)
38—38·9	♂	40·8 (2)	38·7 (2)	8·6 (2)	15·4 (2)	10·3 (2)	8·9 (2)	21·6 (2)	24·1 (2)	27·3 (2)	30·5 (2)	63·7 (2)	64·1 (2)	64·3 (2)	15·7 (2)	12·5 (2)	7·8 (2)	7·2 (2)	17·3 (2)
,,	♀	39·7 (2)	37·9 (2)	8·8 (2)	15·4 (2)	10·8 (2)	8·8 (2)	21·7 (2)	23·4 (2)	28·1 (2)	30·7 (2)	64·4 (2)	65·0 (2)	65·6 (2)	15·8 (2)	12·3 (2)	7·6 (2)	7·4 (2)	17·8 (2)
39—39·9	♂	41·0 (1)	40·5 (1)	8·7 (1)	14·4 (1)	10·7 (1)	8·7 (1)	22·5 (1)	24 (1)	28·5 (1)	30·5 (1)	64·2 (1)	65·2 (1)	66·5 (1)	15·7 (1)	12·4 (1)	7·7 (1)	7·5 (1)	17·5 (1)
,,	♀	41·3 (4)	39·0 (4)	8·8 4)	16·2 (4)	11·0 (4)	8·7 (1)	21·6 (4)	22·1 (4)	27·0 (2)	30·0 (4)	64·3 (4)	65·1 (4)	65·6 (4)	15·8 (4)	12·2 (4)	7·5 (4)	7·5 (4)	18·2 (4)
40—40·9	♂	41·3 (1)	39·4 (1)	8·8 (1)	15·0 (1)	10·3 (1)	8·2 (1)	21·6 (1)	22·5 (1)	26·8 (1)	29·8 (1)	64·2 (1)	65·2 (1)	65·9 (1)	15·5 (1)	11·8 (1)	7·2 (1)	7·0 (1)	18·7 (1)
,,	♀	41·1 (4)	39·5 (4)	9·1 (4)	16·1 (4)	11·1 (4)	8·9 (4)	21·6 (4)	22·9 (4)	27·3 (4)	29·9 (4)	63·3 (4)	64·6 (4)	65·1 (4)	15·9 (4)	12·1 (4)	7·4 (4)	7·5 (4)	18·4 (4)
41—41·9	♂	41·7 (2)	39·6 (2)	9·4 (2)	15·5 (2)	11·0 (2)	8·9 (2)	21·9 (2)	23·3 (2)	25·7 (2)	30·6 (2)	63·5 (2)	64·3 (2)	65·4 (2)	15·9 (2)	12·3 (2)	7·7 (2)	7·4 (2)	18·8 (2)
,,	♀	40·8 (1)	38·4 (1)	9·0 (1)	15·0 (1)	10·8 (1)	8·5 (1)	21·6 (1)	23·2 (1)	27·8 (1)	29·0 (1)	64·1 (1)	63·6 (1)	64·3 (1)	15·8 (1)	12 (1)	7·7 (1)	7·7 (1)	18·4 (1)
42—42·9	♂	43·7 (1)	39·8 (1)	9·4 (1)	13·0 (1)	11·1 (1)	9·9 (1)	21·6 (1)	22·7 (1)	26·7 (1)	30·6 (1)	63·6 (1)	64·8 (1)	65·3 (1)	16·4 (1)	12·6 (1)	7·8 (1)	7·5 (1)	18·7 (1)
,,	♀	43·4 (2)	40·2 (2)	8·9 (2)	13·8 (2)	10·5 (2)	8·7 (2)	21·3 (2)	21·9 (2)	25·3 (2)	30·1 (2)	62·7 (2)	65·4 (2)	66·0 (2)	15·5 (2)	11·9 (2)	7·2 (2)	7·1 (2)	17·8
43—43·9	♀	41·4 (2)	38·8 (2)	9·1 (2)	15·0 (2)	10·5 (2)	8·3 (2)	21·2 (2)	22·5 (2)	26·2 (2)	29·8 (2)	63·7 (2)	64·6 (2)	65·5 (2)	15·3 (2)	11·8 (2)	7·5 (2)	7·3 (2)	18·4 (2)

Table IXa.

Analysis of the Variations in the Number of Fin-rays in the Mackerel from each Locality.

Locality.	Sex.	First Dorsal								Second Dorsal.					Dorsal Finlets.				Anal.							Anal Finlets.			
		No.	10	11	12	13	14	15	16	No.	11	12	13	14	No.	4	5	6	No.	9	10	11	12	13	14	No.	4	5	6
Aberdeen.	♂	*111*	..	1	16	36	41	14	3	*112*	9	96	7	..	*111*	1	109	1	*112*	..	..	13	96	2	1	*112*	2	108	2
	♀	*93*	..	2	14	32	32	11	2	*95*	14	76	5	..	*95*	3	90		*96*	1	1	7	82	4	..	*95*	1	92	2
	♂+♀	*204*	..	3	30	68	73	25	5	*207*	23	172	12	..	*206*	4	199	3	*207*	1	1	20	178	6	1	*207*	3	200	4
Loch Fyne and Kilbrennan Sound.	♂	*90*	1	..	14	35	25	15	..	*91*	12	75	4	..	*91*	2	88	1	*90*	..	1	10	76	3	..	*91*	2	87	2
	♀	*89*	1	1	17	32	23	13	2	*89*	11	73	4	1	*90*	..	89	1	*89*	..	2	15	70	2	..	*90*	2	85	3
	♂+♀	*181*	2	1	31	68	48	29	2	*182*	24	149	8	1	*183*	2	179	2	*181*	..	3	25	148	5	..	*183*	4	174	5
Barra and Stornoway.	♂	*34*	..	..	3	10	14	6	1	*33*	3	29	1	..	*35*	2	33	..	*35*	..	..	4	29	2	..	*35*	1	34	..
	♀	*43*	..	1	..	18	11	9	3	*42*	5	37	..	..	*43*	..	42	..	*42*	..	..	4	36	2	..	*42*	..	41	1
	?	*11*	..	..	3	3	3	2	..	*11*	1	10	..	..	*11*	1	10	..	*11*	..	..	..	10	1	..	*11*	..	11	..
	♂+♀	*87*	..	1	6	31	28	17	4	*86*	9	76	1	..	*88*	3	85	..	*88*	..	..	8	75	5	..	*88*	1	86	1

Previous Work on the Races of Mackerel.

The mackerel caught off the southern coasts of Ireland and England have been investigated by Garstang. Owing to the fact that the present research has been conducted on different lines from his work, it is not possible to institute a very close comparison. It may not, however, be unprofitable to review the results obtained by that author, more especially with regard to the correlation of the variations of the numbers of finlets and dorsal fin-rays.

Garstang established among the European mackerel which he examined, two races, viz., the Irish (Kerry and Kinsale) mackerel and the North Sea and English Channel variety. The characters upon which he founded his comparison were—(1) the number of transverse bars; (2) the number of transverse bars which cross the lateral line; (3) the number of dorsolateral intermediate spots; (4) and (5) the number of fin-rays in the first and second dorsal fins; (6) the number of dorsal finlets. With regard to the first of these characters the author says:—"The bars are not always distinct and parallel, but are frequently branched and anastomosed with one another, broken or otherwise irregular, rendering the task of enumeration not always easy, and so introducing a certain subjective element into the records." In the case of the second character, viz., the number of bars that cross the lateral line, another interfering factor is present, namely, the irregularity of the lateral line in its course. By means of the third character—the "spottiness" of the fish—he was enabled to separate the American examples from the European specimens. I have not adopted these characters for the present research, because in such a case, where the colour-markings are so irregularly disposed, that the two sides of the one fish generally differ in the arrangement of the bars, too much will depend upon the observer, and too little upon any rule which can be enunciated for guidance. Owing to this a comparison between the results of different workers would be difficult, if not impossible. As regards the number of rays in the first dorsal fin, I have found a considerably higher average than was found by Garstang in his specimens. The highest average which he found was 12·5 rays (in the Scilly mackerel), while for Plymouth the average was 12·18. The lowest average which I obtained was 13·4 (for the Clyde fish), while the Aberdeen specimens gave 13·5, and the Barra and Stornoway, 13·76. Moreover, the evidence accumulated by his investigation of this character indicated that a reduction in the number of recognisable fin-rays accompanied the increase in length of the fish. This reduction, he is inclined to believe, is due to the concealment of the minute posterior rays by the encroachment of the surrounding tissues on the lower part of the fin. Their concealment is not a sufficient description of the reduction in number of the recognisable rays. The mackerel which I have examined do certainly afford a slight indication of a reduction due to growth, as the following Table shows; but the evidence here furnished is not conclusive. I have arranged all the mackerel of which I have noted the number of first dorsal rays into two-centimetre groups. The number of specimens in each, and the average for each group, are given alongside.

[Table.

Cm.	No.	Average.	Cm.	No.	Average.
26–28	15	13·6	—	—	—
29–31	63	13·4	—	—	—
32–34	256	13·7	26–33	245	13·55
35–37	108	13·2	35–43	227	13·47
38–40	22	13·59	—	—	—
41–43	8	14·1	—	—	—

But since the groups are so irregular as regards the numbers of mackerel in each I have divided the whole number into two groups of from 26–33 and 34–43cms. By this arrangement a slight reduction in the number of rays is indicated in the group of larger fish; the averages being 13·55 for the less, and 13·47 for the larger. Two groups of mackerel which Garstang compares with the object of showing this decrease give more indication of the reduction; *e.g.*, 129 mackerel of from 5½–10½ inches gave an average of 12·49 rays, while 127 of from 12½–15¾ gave an average of 12·02. The discrepancy between the average numbers of rays obtained by Garstang and by myself can only be due to a difference in the interpretation of the term recognisable. And herein lies the difficulty of counting the rays of this fin. In almost every fish one ray at least was completely sunk beneath the skin, and, notwithstanding its minute size, if its articular base was made out, it was counted as a ray.

Second Dorsal Fin and Dorsal Finlets.

The average number of rays found by Garstang for this fin, viz. North Sea and English Channel 11·946, Brest and Scilly 11·948, and for Ireland, S. and W., 11·933, agree very closely with what I found in the Scottish fish, viz., 11·95 for Aberdeen, 11·92 for the Clyde, and 11·91 for Barra and Stornoway. The average for the dorsal finlets of the same southern localities were 5·009, 4·994, 5·011, while those for the Scottish districts were 4·996, 5, and 4·96. Here, again, a close agreement is seen.

The Correlation between the Variations in the Numbers of the Rays of the Second Dorsal and Anal Fins, and the Dorsal and Anal Finlets.

Garstang draws attention to the correlation between the variations of the second dorsal fin and the number of dorsal finlets, and from an analysis of the variation of these organs in a number of American mackerel makes the following generalisations:—(1) "That the normal or modal number of fin-rays (12) is constantly associated with the normal or modal number of finlets (5); (2) that when the number of fin-rays is below 12, the variation in the number of finlets is confined to deviations above the mode (5); (3) that when the number of fin-rays is above 12, the deviations from the modal number of finlets are exclusively below the mode; (4) that the normal number of finlets (5) is associated with a wide range of variation in regard to the number of rays in the second dorsal fin (from 10–14); (5) that when the number of finlets is above five, the number of rays is constantly below 12; and (6) that when the number of finlets is below 5, the number of rays is constantly above 12." Nos. 1, 5, and 6 do not hold good for Scottish mackerel, as the following Table will show.

Table to show the numbers of second dorsal fin-rays which have been found associated with each number of finlets, and the observed frequency of each combination in 474 mackerel:—

Dorsal Finlets.	Second Dorsal Fin-rays.			
	11	12	13	14
4	—	5	4	—
5	52	392	16	1
6	1	3	—	—

It is thus evident that the normal or modal number of fin-rays of the second dorsal (12) is associated with the two variations (4 and 6) of the finlets, and in the present instance that association occurs more frequently than what might be called the compensating association of a higher number of fin-rays, *e.g.*, 13, with a lower number of finlets, *e.g.* 4. The following Table gives an analysis of 476 Scottish mackerel in respect to the variation in the number of anal finlets and their association with variations in the number of the anal fin-rays:—

Anal Finlets.	Anal Fin-rays.					
	9	10	11	12	13	14
4	—	—	—	2	6	1
5	1	2	44	396	12	—
6	—	1	6	3	—	—

It is here seen that in this case also a similar relation is found, viz., that the normal or modal number of fin-rays (12) is associated with both variations from the modal number of finlets. The following generalisation is then warranted, viz., that the modal number of rays of the second dorsal and anal fins (12) is to be found associated with the two variations (4 and 6) of the dorsal and anal finlets; and, further, that with a variation in the number of finlets either above or below 5, if the modal number of the rays of the related fin is not found associated therewith, the rays will be found to vary in number from 12 inversely as the finlets vary from 5.

It is, again, apparent from these two Tables that, as Garstang records in his fourth generalisation, the normal number of finlets (5) is associated with a wide range of variation in the number of fin-rays. A converse of the generalisation made above with regard to the variations in the finlets holds good also for variations in the fin-rays, viz., that the modal number of finlets is found associated with most of the variations in the number of rays; and, further, that with a variation in the number of finlets either above or below 12, if the modal number of finlets be not associated therewith, the finlets will be found to vary in number from 5 inversely as fin-rays vary from 12. This applies to both dorsal and anal couples (fin-rays and finlets). These two propositions may be stated more briefly:—

(1) When the number of finlets varies, the number of fin-rays remains normal, or *varies in the opposite sense.*

(2) When the number of fin-rays varies, the number of finlets remains normal, or *varies in the opposite sense.*

The variation of the finlets in the opposite sense to the fin-rays is more apparent than real. So long as a distinction is made between the fin-rays and the finlets, the compensating variation seems to occur. But the finlets are really detached rays of the second dorsal fin. Very often a finlet remains attached to the fin, and occasionally a fin-ray becomes detached from the fin, in which cases we get such compensating variations as 13 fin-rays and 4 finlets and 11 fin-rays and 6 finlets, which of course together give the normal total 12 + 5 (17). In these compensating variations there is no real variation in number, simply a slight variation in location. The rearrangement (in brackets) of the figures in Table X. eliminates this compensating variation. The generalisation may therefore be, with great probability, simplified thus—(1) that with variations in the number of finlets there are associated the normal number of fin-rays; (2) that with variations in the number of fin-rays there are associated the normal number of finlets.

TABLE X.

Combination of Variations in One Couple with the Normal in the other.

Variations in Dorsal Couple.					Variations in Anal Couple.				
2nd Dorsal Fin-rays.	Dorsal Finlets.	Anal Fin-rays.	Anal Finlets.	Frequency.	Anal Fin-rays.	Anal Finlets.	2nd Dorsal Fin-rays.	Dorsal Finlets.	Frequency.
13 (12)	4 (5)	12	5	4	13 (12)	4 (5)	12	5	5
12	4	12	5	4	12	4	12	5	2
12	4	11 (12)	6 (5)	1	14 (13)	4 (5)	12	5	1
11 (12)	6 (5)	10 (11)	6 (5)	1	13 (12)	4 (5)	11	5	1
12	6	12	6	3	13 (12)	4 (5)	13	5	1
–	–	–	–	–	11 (12)	6 (5)	12	5	5

TABLE XI.

Variations in the Number of 2nd Dorsal Fin-rays, accompanied by Normal Number of Dorsal and Anal Finlets.					Variations in the Number of Anal Fin-rays, accompanied by Normal Number of Dorsal and Anal Finlets.				
2nd Dorsal Fin-rays.	Dorsal Finlets.	Anal Fin-rays.	Anal Finlets.	Frequency.	Anal Fin-rays.	Anal Finlets.	Dorsal Fin-rays.	Dorsal Finlets.	Frequency.
11	5	12	5	35	11	5	12	5	34
12	5	12	5	337	13	5	12	5	6
13	5	12	5	12	11	5	11	5	8
14	5	12		1	13	5	11	5	3
–	–	–	–	–	11	5	13	5	1
–	–	–	–	–	9	5	11	5	1

TABLE XII.

A. Variations in Dorsal Combination.			B. Variations in Anal Combination.			C. Additional Variations in Dorsal and Anal Combinations.		
2nd Dorsal Fin-rays and Finlets.	Anal Fin-rays and Finlets.	Frequency.	Anal Fin-rays and Finlets.	Dorsal Fin-rays and Finlets.	Frequency.	Dorsal Fin-rays and Finlets.	Anal Fin-rays and Finlets.	Frequency.
-	-	-	16	17	38	16	14	1
14	17	1	18	17	7	16	16	8
16	17	41	-	-	-	16	18	3
18	17	13	17	17	351	18	16	1
19	17	1	-	-	-	18	18	3

Correlation between the Dorsal Couple (2nd Dorsal Fin-rays and Dorsal Finlets) and the Anal Couple (Anal Fin-rays and Anal Finlets).

For the purpose of this comparison, each set of fin-rays and finlets is added together. The normal number is 17 in each case. The correlation which is found to exist is as follows:—That a variation from the normal number in the dorsal couple is accompanied by the normal number in the anal couple, and *vice versa*. This proposition will be modified later, when the exceptions to this rule are considered. In Tables X. and XI. are set forth the various combinations of fin-rays and finlets which were present in 468 mackerel (♂ and ♀); and in Table XII. the number of fin-rays and finlets are added for each couple. In the divisions A and B all the variations which agree with the above generalisation are entered. In division C are the exceptions. They are 16 in number. One variation, which occurred eight times, is a decrease in the dorsal couple, accompanied by a similar decrease in the anal—viz., 16 in each; while a second variation, in which both couples were equally increased—viz., 18 in each—occurred three times. In these two cases, then, we have accompanying a decrease or an increase in one couple an equal decrease or increase in the other. There remain five cases, in four of which a decrease in one couple was accompanied by an increase to the same amount in the other couple—viz., 16 and 18 and 18 and 16. The last exception—viz., dorsal 16, anal 14—is one in which an abnormally low number of anal fin-rays—viz., nine—was found. This reduction is possibly due to injury. Two other cases in which abnormally low numbers were found—*e.g.*, in one, two dorsal finlets and in the other eight dorsal fin-rays—have been left out, since they were evidently due to injury. A generalisation which would include all the cases (with the exception of the three supposed abnormal cases) is as follows:—A variation in one couple is accompanied by the normal number, or by an *equal* deviation in the same or opposite sense in the other. It is very possible and probable that the variations in the dorsal and anal couples may be sometimes correlated with variations in the number of caudal rays, and such a relation may be present in the case of those exceptions which required a widening of the proposition. I have, however, no data bearing on the number of caudal rays.

An attempt was made to find what correlation, if any, existed between the number of rays of the first dorsal fin and the various combinations of the dorsal and anal couples. These are set out in Table XIII. No connection was very apparent. It would not unnaturally be expected that the first dorsal fin would vary quite independently of the dorsal couple, and this is probably the case.

[TABLE.

Table XIII.

Combination of Fin-rays of First Dorsal Fin with the Second Dorsal and Anal Fins and the Dorsal and Anal Finlets.

Nature of Variations.	Frequency.	2nd Dorsal and Anal Fin-rays. Dorsal and Anal Finlets.				First Dorsal Fin-rays.						
		2nd Dorsal Fin-rays	Dorsal Finlets.	Anal Fin-rays	Anal Finlets.	10	11	12	13	14	15	16
Dorsal and Anal Combinations: Normal.	338	12	5	12	5	1	5	50	108	109	57	8
Decrease in Dorsal Combination: . .	41	11	5	12	5	–	–	3	19	8	4	2
Anal Normal.		12	4	12	5	1	–	1	2	1	–	–
Decrease in Anal Combination: . .	38	12	5	11	5	–	–	4	17	10	4	–
Dorsal Normal.		12	5	12	4	–	–	1	–	1	–	–
		12	5	10	6	–	–	–	–	1	–	–
Increase in Dorsal Combination: . .	16	13	5	12	5	–	–	1	8	5	1	–
Anal Normal.		14	5	12	5	–	–	1	–	–	–	–
Increase in Anal Combination: . .	10	12	5	13	5	–	–	1	3	4	1	–
Dorsal Normal.		12	5	14	4	–	–	1	–	–	–	–
Decrease in both Dorsal and Anal . .	14	11	5	11	5	–	–	2	5	2	2	–
Combinations.		11	5	10	5	–	–	1	–	1	–	–
		11	5	9	5	–	–	–	–	1	–	–
Increase in both Dorsal and Anal . .	3	12	6	12	6	–	–	–	1	2	–	–
Combinations.		–	–	–	–	–	–	–	–	–	–	–
		–	–	–	–	–	–	–	–	–	–	–
Decrease in Dorsal: Increase in Anal .	3	11	5	13	5	–	–	–	1	1	1	–
Combination.		–	–	–	–	–	–	–	–	–		
Increase in Dorsal: Decrease in Anal Combination. .	1	13	5	11	5	–	–	1	–	–	–	–

TABLE XIV.

Ripe and Unripe Spent Mackerel.

	Clyde and Barra. (June and July).					Stornoway (August).				Aberdeen (Aug. and Sept.).		Kilbrennan Sound (October).	
	Ripe.		Unripe.			Ripe.	Unripe and Spent.			Unripe and Spent.		Unripe and Spent.	
Length—cm.	♂	♀	♂	♀	?	♀	♂	♀	?	♂	♀	♂	♀
26	–	–	–	1	–	–	–	–	–	–	–	–	–
27	1	–	–	–	2	–	–	–	–	–	–	–	1
28	1	1	–	1	2	–	1	–	1	–	–	3	1
29		1	–	–	–	1	–	–	1	1	1	2	2
30	5	–	–	1	–	–	4	2	3	3	5	2	–
31	5	8	–	–	–	–	1	–	–	11	15	–	1
32	16	19	2	1	–	–	2	2	3	21	32	–	–
33	12	10	–	–	–	–	–	–	1	32	19	–	–
34	21	18	1	–	–	–	1	–	–	31	20	–	–
35	17	25	1	–	–	–	–	–	–	8	2	–	–
36	10	12	–	–	–	–	–	–	–	2	1	–	–
37	4	3	1	–	–	–	–	–	–	3	–	–	–
38	4	6	–	–	–	–	–	–	–	–	–	–	–
39	1	6	–	–	–	–	–	–	–	–	–	–	–
40	1	4	–	–	–	–	–	–	–	–	–	–	–
41	2	1	–	–	–	–	–	–	–	–	–	–	–
42	1	2	–	–	–	–	–	–	–	–	–	–	–
43	–	2	–	–	–	–	–	–	–	–	–	–	–
Totals,	105	118	5	4	4	1	9	4	9	112	95	7	5

The Spawning of the Mackerel.

A certain amount of evidence bearing on the spawning season of the mackerel has been afforded by the fishes examined during this research. Among the mackerel got in Loch Fyne and at Barra in June and July 105 males and 118 females were ripe; four females were unripe, and five males ripe or spent; four specimens of undetermined sex were unripe (*vide* Table XIV.). The total of ripe females included seven spent fish. Twenty-three mackerel were obtained from Stornoway on August 13th; of these,

one female was ripe and three females were spent, while the remainder were unripe (or, in the case of the males, possibly spent). Of the 207 specimens caught off Aberdeen in the latter half4of August and first half of September 95 were females, and of these 8 were spent; nine were ripe. The males were either unripe or spent. In October, 12 fish were sent from Kilbrennan Sound; of these, five were spent females. It is to be inferred, then, that on the West Coast spawning takes place in July and part of August. The lower and upper limits of the spawning season it is so far not possible to fix. The mackerel caught off Aberdeen had ceased spawning by the middle of August. The smallest ripe male was 27·7cm. in length; the smallest ripe female was 28·9cm. long. The smallest ripe male and ripe female mackerel recorded by Cunningham* were 30·3 and 29·5cm. long respectively. He considered that this form had a short spawning period in the vicinity of Plymouth—viz., from the middle of May to the end of July.

Weights of Ripe and Unripe Mackerel.

The accompanying Table (XV.) gives some particulars of the weight of ripe and unripe mackerel at various sizes. The average weight is given for all the mackerel at each size, the number of specimens from which the average is made being indicated by a number within brackets. In most instances the average weight of the unripe male exceeds that of the ripe male. In two cases—viz., at 32 and 35cm.—the ripe male exceeds the unripe by 10 and 7 grammes respectively. At 33cm. the unripe male exceeds the ripe by 39 grammes. There is much greater variation in the relation of the ripe and unripe females to one another. Cunningham records a ripe male of 42·5cm. length weighing 524 grammes; the only ripe male of this size which I have weighed was 837 grammes in weight. The numbers, which are given in Table XV., are not sufficient to permit of any detailed discussion. It is, however, very evident that, so far as they go, they point out, in several cases, that the ripe and unripe males are of very similar weight, and so with the ripe and unripe females, while in other instances they diverge considerably.

* *Loc. cit.*

[TABLE.

Table XV.

Weights (in Grammes) of Ripe and Unripe ♂ and ♀ Mackerel at Different Sizes.

	Length—cm.	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
♂	Ripe	–	201 (1)	225 (1)	259 (4)	275 (4)	311 (4)	337 (12)	381 (10)	415 (13)	471 (11)	507 (8)	562 (4)	587 (3)	605 (3)	712 (1)	721 (2)	837 (1)	–
	Unripe . . .	–	–	242 (3)	278 (2)	302 (2)	344 (4)	327 (4)	420 (6)	417 (5)	464 (3)	–	604 (3)	–	–	–	–	–	–
♀	Ripe	–	–	269 (1)	261 (1)	–	304 (6)	330 (10)	372 (6)	432 (10)	494 (8)	503 (5)	486 (2)	579 (4)	648 (4)	655 (4)	707 (1)	844 (2)	825 (2)
	Unripe . . .	194 (1)	230 (1)	231 (2)	276 (2)	300 (2)	327 (1)	317 (6)	401 (6)	426 (4)	452 (8)	580 (1)	–	–	–	–	–	–	–

VIII.—REPORT ON THE OPERATIONS AT DUNBAR MARINE HATCHERY DURING THE SPRING SEASON 1899.

By Harold C. Dannevig.

As mentioned in last year's Report, the transference of the Dunbar Hatchery to the same site as the Marine Laboratory, Bay of Nigg, Aberdeen, had to be postponed owing to delay in the completion of the large tidal pond, and it was found necessary to continue the hatching operations at Dunbar for another season. Owing to this and to the stormy weather which prevailed during the early part of the year, the collection of spawners was begun in the third week of February. The fish were procured by the "Garland" from steam trawlers as in previous years, and from February 25th to April 1st a total number of 419 male and female plaice were landed and placed in the spawning pond. The collection of the spawners was sometimes a matter of difficulty owing to the stormy weather, and the "Garland" on several occasions found it impossible to land the fish at Dunbar, and had to keep them on board, in tubs, in Granton harbour until the weather moderated, a constant circulation of water being maintained. On two or three occasions it was found desirable to remove the ripe spawn from the fishes at Granton, to fertilise the eggs, and take them on to the hatchery. It has been found that, though in ripe condition at the time of capture, the plaice does not spawn immediately upon being put into confinement. Several days, or even more than a week, may elapse before the regular spawning commences. But, as has been stated in previous Reports, this regular spawning, or a daily production of fecundated eggs, is preceded by the extrusion of non-fertilised eggs—eggs that have been retained in the ovaries or oviduct so long that they are incapable of fecundation. This retention of ripe eggs appears, in the first instance, to be due to fright, discomfort, or bodily injury to the fish; and if it is not continued for a sufficiently long time to allow any quantity of ripe eggs to accumulate has not serious consequences. Once the overdue eggs have been got rid of a normal spawning follows; but if a large number of eggs are retained in the ovaries and oviduct the latter becomes congested, and serious consequences for the fish may be apprehended. The as yet healthy ovary continues to swell by the development of new eggs, and if the outlet is closed it is easily seen how the ovaries may reach such a distended condition as to be dangerous not only to this organ but to the fish itself. The immediate consequences are that a fish in such a condition becomes inactive, and does not take any food. If the capture has inflicted any superficial injury in the region of the ovary, inflammation soon sets in, and the tenacity of the abdomen becomes reduced. The constantly increasing pressure in the ovary may gradually force a portion of this organ through the inflamed tissue and leave it exposed. If, however, the abdomen is healthy and able to withstand the ovarian pressure, the intestines become pushed forward and partly out through the anus; while the foremost part of the oviduct is often also pushed out externally. As in all these cases the fish is rendered useless for breeding purposes, and almost invariably will die in the course of the season, I have found it expedient at once to kill such specimens. In

other cases, when the ovarian pressure is not sufficiently great to cause such injury as that described, the eggs will gradually begin to disintegrate, and the once very hard ovary becomes softer, while the pressure is gradually diminished. In the course of the summer the disintegration leaves the contents of the ovary in a semi-fluid condition, containing fragments of the broken-up egg—capsules. While pressure is still present part of this fluid may escape through the oviduct, and if a fish in such a condition is placed upon a table some of this fluid generally flows out. But I have observed that once the ovary of the plaice has been excessively distended for any length of time it does not again contract freely, and it is not therefore able to expel the entire contents, and a certain portion of it must consequently become absorbed before a normal state is established. From observations made during the months of December and January upon plaice that had been egg-bound during the previous season, it appears that this absorption is not always completed at that time of the year, although I always found small eggs, with more or less yolk, developing from the walls of the ovary.

The above-mentioned difficulties have a great effect upon the success of the hatching work as regards the number of fertilised eggs that may be obtained from fish that have been captured immediately before or during the course of the spawning season; and the necessity of having the breeding-stock of plaice collected at some other period of the year by which these difficulties could be avoided, is therefore apparent. While working at Dunbar, where the plaice had to be landed by the "Garland," it was necessary, for the sake of time, to collect the fish when caught in the greatest number—viz., when they gather on the offshore spawning grounds. But as other facilities may be utilised from the port of Aberdeen, it is to be hoped that the necessary supply of adult plaice may be secured at the most suitable time of the year, as it is intended to retain the fish from year to year.

TABLE I.—SHOWING THE DAILY PROGRESS OF THE HATCHING WORK DURING THE SPRING SEASON 1899.

Date.	Number of Eggs Collected.	Number of Eggs Found Dead in Boxes.	Number of Fry put out.	Total Number of Eggs and Fry in Boxes.	Sp. Gravity and Temperature at Noon of the Water in the Hatchery.	
					Sp. Gravity.	Centigr.
March 10th.	65,000	-	-	65,000	1027·3	4·9
,, 11th.	-	-	-	65,000	1027·3	4·8
,, 12th.	60,000	-	-	125,000	1027·2	4·9
,, 13th.	-	-	-	125,000	1027·2	5·0
,, 14th.	75,000	-	-	200,000	1027·0	5·2
,, 15th.	-	-	-	200,000	1027·0	5·1
,, 16th.	90,000	-	-	290,000	1027·1	5·4
,, 17th.	70,000	-	-	360,000	1027·0	5·6
,, 18th.	185,000	20,000	-	525,000	1027·0	5·8
,, 19th.	220,000	-	-	745,000	1027·0	5·7
,, 20th.	250,000	-	-	995,000	1026·9	5·5
,, 21st.	295,000	-	-	1,290,000	1027·0	5·2
,, 22nd.	350,000	-	-	1,640,000	1027·1	5·4
,, 23rd.	535,000	35,000	-	2,140,000	1027·1	5·7
,, 24th.	545,000	-	-	2,685,000	1027·0	5·9
,, 25th.	650,000	-	-	3,335,000	1027·1	6·4
,, 26th.	670,000	-	-	4,005,000	1027·3	6·3
,, 27th.	800,000	155,000	-	4,650,000	1027·4	6·5
,, 28th.	750,000	-	-	5,400,000	1027·3	6·4
,, 29th.	780,000	-	-	6,180,000	1027·1	6·2
,, 30th.	660,000	-	-	6,840,000	1027·0	6·5
,, 31st.	500,000	-	-	7,340,000	1027·3	6·7
April 1st.	640,000	80,000	-	7,900,000	1027·1	6·4
,, 2nd.	680,000	-	-	8,580,000	1026·8	6·2
,, 3rd.	760,000	-	-	9,340,000	1026·9	6·5
,, 4th.	690,000	230,000	-	9,800,000	1026·9	6·7
,, 5th.	750,000	-	-	10,550,000	1027·1	6·3
,, 6th.	760,000	-	-	11,310,000	1027·2	6·6
,, 7th.	790,000	165,000	-	11,935,000	1027·3	6,3
,, 8th.	780,000	-	-	12,715,000	1027·2	6·8
,, 9th.	740,000	-	-	13,455,000	1027·3	6·7
,, 10th.	600,000	215,000	-	13,840,000	1027·2	6·9
,, 11th.	540,000	-	-	14,380,000	1027·3	6·9
,, 12th.	390,000	280,000	775,000	13,715,000	1027·0	7·2
,, 13th.	470,000	-	-	14,185,000	1027·1	7·1
,, 14th.	430,000	290,000	-	14,325,000	1027·0	7·3
,, 15th.	340,000	-	-	14,665,000	1027·2	7·3
,, 16th.	320,000	120,000	-	14,865,000	1027·4	7·5
,, 17th.	300,000	-	1,500,000	13,665,000	1027·2	7·2
,, 18th.	310,000	130,000	-	13,845,000	1027·1	7·4
,, 19th.	270,000	-	-	14,615,000	1026·9	7·0
,, 20th.	180,000	110,000	2,625,000	11,560,000	1027·0	6·8
,, 21st.	130,000	-	-	11,690,000	1027·2	6·9
,, 22nd.	-	-	-	11,690,000	1027·3	6·3
,, 23rd.	150,000	85,000	-	11,755,000	1027·2	7·1
,, 24th.	-	-	-	11,755,000	1027·0	7·3
,, 25th.	60,000	-	800,000	11,015,000	1027·4	7·2
,, 26th.	-	60,000	-	10,955,000	1027·0	7·4
,, 27th.	50,000	-	-	11,005,000	1027·3	7·5
,, 28th.	-	-	1,400,000	9,605,000	1027·1	7·1
,, 29th.	20,000	-	-	9,625,000	1027·0	7·6
,, 30th.	-	-	-	9,625,000	1027·3	7·3
May 1st.	-	85,000	1,400,000	8,140,000	1027·2	7·5
,, 2nd.	-	-	-	8,140,000	1027·4	7·6
,, 3rd.	-	-	1,200,000	6,940,000	1027·5	7·7
,, 4th.	-	55,000	-	6,885,000	1027·3	7·4
,, 5th.	-	-	1,100,000	5,785,000	1027·1	7·7
,, 6th.	-	40,000	-	5,745,000	1027·2	7·5
,, 7th.	-	-	-	5,745,000	1027·1	7·3
,, 8th.	-	-	1,200,000	4,545,000	1027·0	7·9
,, 9th.	-	20,000	-	4,525,000	1027·0	7·8
,, 10th.	-	-	900,000	3,625,000	1027·0	8·2
,, 11th.	-	35,000	-	3,590,000	1027·1	8·1
,, 12th.	-	-	1,200,000	2,390,000	1027·0	8·1
,, 13th.	-	-	-	2,390,000	1027·3	8·4
,, 14th.	-	-	-	2,390,000	1027·4	8·3
,, 15th.	-	20,000	1,100,000	1,270,000	1027·1	8·5
,, 16th.	-	-	-	1,270,000	1027·0	8·7
,, 17th.	-	-	-	1,270,000	1027·0	8·6
,, 18th.	-	-	-	1,270,000	1027·2	8·9
,, 19th.	-	-	1,270,000	-	1027·1	8·8

From the adjoining Table I., which shows the daily progress of the hatching work, it will be seen that the first collection of fecundated eggs was made on March 10th, or thirteen days after the first lot of fish were landed. The total number of eggs collected in the course of the season was 18,700,000, and of these 2,230,000, or not quite 12 per cent., were lost during the process of incubation. The remaining 16,470,000 were successfully hatched, and the larvæ transported to the upper part of Loch Fyne, where they were distributed at various places to the north-east of a line between Inveraray and the Poll Point. After heavy rains the salinity of the surface water in the upper part of the loch is often much reduced, and in such cases the fry were lowered down into water of a density of 1022·5 or more. The particulars in each case are shown in the subjoined Table II. :—

TABLE II.

Showing the Physical Conditions under which the Fry were Planted in Loch Fyne.

Date.	Locality.	Surface. Density and Temp.	5 Fthms. Density and Temp.	20 Fthms. Density and Temp.	Tide.	Wind.	Number of Fry Planted.
April 12	Off St. Catherine's, ...	1022·5 / 7·8° C.	1025·6 / 7·7° C.	1026·6 / 7·7° C.	L.W.	Calm.	775,000
„ 17	Under Strone Point, ...	1023·5 / 8·4	1025·9 / 8·1	1026·1	3h. ebb.	N.E., force 1.	1,500,000
„ 20	Do., ...	1020·1 / 8·9	1024·8 / 8·5	1025·2 / 8·4	2h. ebb.	Varying.	2,625,000
„ 25	Off Poll Point, ...	1018·2 / 9·9	1025·2 / 9·0	1025·6 / 8·5	½h. flood.	Calm.	800,000
„ 28	Do., ...	1020·3 / 10·5	1024·3 / 10·0	1025·1 / 9·5	L.W.	E., force 3.	1,400,000
May 1	Off Dunderave Castle, ...	1023·0 / 8·9	1025·7 / 8·9	1025·1 / 9·5	3h. ebb.	N.E., force 1.	1,400,000
„ 3	Do., ...	1025·2 / 9·4	1026·4 / 9·9	1025·1 / 9·5	H.W.	Calm.	1,200,000
„ 5	Off Inveraray, ...	1025·6 / 9·4	1026·3 / 8·9	1026·4 / 8·9	4h. flood.	E., force 1.	1,100,000
„ 8	Between Strona Point and St. Catherine s,	1025·4 / 10·5	1025·5 / 10·5	1025·9 / 9·5	2h. flood.	N.E., force 1.	1,200,000
„ 10	Off Poll Point, ...	1025·6 / 10·5	1025·6 / 10·1	1026·5 / 10·1	1h. flood.	Calm.	900,000
„ 12	Do., ...	1025·8 / 9·0	1026·0 / 9·0	1026·2 / 9·5	L.W.	N., force 2.	1,200,000
„ 15	Off Strona Point, ...	1024·7 / 9·5	1025·9 / 9·3	1026·1 / 9·2	3h. ebb.	Calm.	1,100,000
„ 19	Off Inveraray, ...	1020·2 / 10·1	1024·3 / 10·0	1025·1 / 9·8	H.W.	N.E., force 2.	1,270,000

IX.—THE CLASSIFICATION OF THE FLAT-FISHES (*Heterosomata*).

By H. M. Kyle, M.A., B.Sc., Science Scholar, St. Andrews.

(Plates XI., XII.).

CONTENTS.

	PAGE
Introduction	335
Description of Characters	335
Characters of most importance for classification	348
Classification	351
Geographical Distribution	362

INTRODUCTION.

The present work was begun during the winter of 1898-99 at St. Andrews, was continued as time and opportunity permitted at Heligoland, later at the British Museum of Natural History, and at the Zoological Station at Naples. The opportunities thus afforded for the examination of material—both fresh and in spirit—were exceptional, and a much larger number of specimens and of species have passed through my hands than I had at first thought of or hoped for. I have to thank Prof. M'Intosh, F.R.S., of St. Andrews, and Prof. Heincke and Dr. Ehrenbaum of Heligoland, for the use of the Marine Laboratories at St. Andrews and Heligoland; Mr. Boulenger, F.R.S., especially for the kindness, encouragement, and aid I received whilst working at the British Museum of Natural History; also the British Association for the Advancement of Science, through the secretary, Prof. Howes, F.R.S., for the honour of occupying their Table at the Naples Marine Station; and the staff of the latter for much kindness and courtesy.

The species which have been examined include the majority of the European forms, representatives of the chief genera of the American flat-fishes, and of those of the Indian, China, and Australasian seas. In spite of the large number of species which has been examined, the number unexamined is very much larger, so that the present classification does not profess to be complete, but merely offers a certain outline into which the various groups fit, and displays in a manner easily grasped the gaps in our present knowledge of these forms. The origina aim was to trace out the natural affinities of the various sub families and the changes in their characters with geographical distribution, by the study of their internal structure as well as of their external characteristics. The results that have come to the surface, and perhaps one might say the "cream" of the work which has been done, are here gathered together into the present paper, and it is hoped—if the opportunity is given—to enter more in detail into the anatomy and development of the flat-fishes, and thence be able to eliminate the shortcomings of the present work, and give fuller descriptions of the specific and generic differences within the *Heterosomata*.

External Characters.

The great majority of the external characters—scales, coloration, fin-rays—are only of specific importance in the *Heterosomata*. These are characters which vary greatly and give rise to great difficulties even in

the separation of species. Of somewhat greater value are the relative dimensions which are usually given of different parts of the body. These are also subject to great variation, and are in many cases useless and misleading. Yet if those dimensions are chosen which express the "form" of the species, and sufficient examples are measured, one can readily see that they should be of great value. For example, the "form" of the Plaice, Flounder, and Halibut cannot be mistaken for that of a Turbot, and neither for that of a Lemon-dab or a Sole. Apart from the general "form" the dimensions of parts, *e.g.* of the lengths of fins or of the mandible, the breadth of the interorbital space, and so on, are of no more than specific value.

The indefinite nature of the external form of the flat-fish is shared by various other characters which constitute the external appearance of the animal. They seem at first sight to be definite, even generic characters, and thus worthy of being ranked as important in a system of classification, but yet when examined more closely they seem capable of indefinite and indeterminable variation. One of these characters is the position which the eyes occupy, whether on the left or right side of the animal. By some writers (40) this character has been ranked as of generic importance, but most systematists have given it a subordinate rank. A great deal might be said for both sides. When we find that a character varies even within the limits of a species, as this one does for many species both of the European and American fauna, we are apt to regard it as useless for classificatory purposes. And yet if we omit these variable species we find that this character is constant and generic. Further, if we disregard what are evidently abnormalities, such as Turbots with arrested migration of the eye, we find that the variable species are transitional forms of some kind or other. This character is therefore employed as of great importance in the present classification. It aids to bring out the affinities of the different groups, and it will be shown how even the variable forms, when properly classified, serve the same purpose.

Another character of the same description is found in the position of the anterior extremity of the dorsal fin on the head. This was employed as generic by Günther and previous writers, but discarded by more recent systematists. Taken by itself, this character suffers from our inability to give it a clear definition, but when considered in its relation to the position of the nasal organ of the blind side, as will be done later, it is one of the most important characters. The reason for this is not far to seek. It is certain that the flat-fishes are descended from some type of round-fish, and in the latter the dorsal fin does not extend forward over the head. Hence the different degrees we find in the forward extension of this fin should mark the different stages in specialisation of the various groups of flat-fishes. Such, as we pass from the Halibut-group through the Plaice- and Turbot-groups to the Soles, is indeed the case, and the only difficulty in the way of employing this character is our inability to define properly the position of the anterior extremity of the fin. By employing the position of the nasal organ we obtain a character which is more easily expressed, although both characters, as will be shown later, must be taken together in measuring affinities.

The *size of the mouth* was another character considered by Günther as of even greater importance than the position of the anterior extremity of the dorsal fin, and which has also been degraded from this high importance by the American writers. It has, indeed, far less to recommend it than the former character. The Turbots and Halibut, for example, are grouped together by Günther under

the wide-mouthed species, and separated from the Plaice and its allies as small-mouthed species. Such a classification very obviously distorts the real affinities, because in all other important characters the Plaice and Halibut groups come together and separate themselves widely from the Turbots. Nevertheless, if we disregarded all consideration of affinities, and endeavoured empirically to find those characteristics which displayed best the general resemblances and differences, this would be one of the characters chosen. It is of the most widespread general nature, and there are very few transitional forms between the wide-mouthed groups with teeth almost equally developed on both sides of the jaws, and the small-mouthed group with teeth more developed on the under sides of the jaws than on the upper. Jordan cites a transitional form (32, p. 285), but none have been seen by myself. Yet this character, for the reason stated above, can only be regarded as of secondary importance in tracing affinities. It is almost certain, for example, that the original primitive form was wide-mouthed, akin to a Gadoid. Shall we say, then, that the Turbot, which has retained this character but has altered in many others, is more nearly allied to the primitive form than the Plaice, which has altered in this character but retained the others? Even if it were a case of balancing the mere number of characters which had altered in these groups, we should decide that the Plaice-group was more akin to the primitive form, but the relative importance of the characters weighs in the same direction. The mouth is not on the same footing as, for example, the structure of the pectoral girdle, the position of the anterior extremity of the dorsal fin, or the structure of the olfactory organ. In the discussion of the various influences that affect the characters, and of the relative importance of characters, it will be shown how the Turbot-group is in reality more specialised and distant than the Plaice-group from the Halibut and thence the primitive stock.

The relative positions of the various bones which form the boundaries of the mouth—premaxilla, maxilla, and mandible—as well as the configuration of the bones which form the palatine and hyomandibular arches, are not exactly the same in the different groups, but how far the differences are generic, how far only specific adaptations, has not yet been determined. This is also the case with the bones forming the gill-covers and the hyoidean arch underneath. There are certain differences present, but they are overbalanced by the general resemblances. Externally, the differences with regard to the opercular bones are most marked in the Sole-group. In this the bones are thin and slender, and their contours are completely hidden by the thick overlying skin, whilst in the other groups the skin is relatively not so thick, and the contours are well marked. This difference, which can be correlated to the more sand-loving habits of the Soles, has been used by Jordan and other American writers to differentiate this group from the others. It is not the sort of character that the morphologist would lay stress upon, but its general nature makes it useful to the systematist. Accompanying it is another important characteristic of the Soles, namely, the almost universal development of a "snout" anterior to the mouth. This was employed by Günther, and the two characters taken together—signifying as they do a definite specialisation in habits—fitly mark the separation and distinctiveness of the Sole-group from the others.

Certain other external differences between the various groups will be considered under separate headings, because they accompany internal differences in organs and structures.

Nasal Organ.

The nasal organs show important differences in the various groups under consideration, even superficially. If the animals are regarded from in front, it will be at once remarked that the position of the nasal organ of the blind side relative to the anterior extremity of the dorsal fin is not the same in all the groups. These differences in position are related to the varying amounts of torsion which the organ of the blind side has undergone during the migration of the eye of that side.

In most species of the Halibut- and Citharus-groups the nasal organ of the blind side lies on the ridge of the head, *i.e.* on the median longitudinal line of the body, and directly in front of the anterior extremity of the dorsal fin (Plate XI., Fig. 2, l.n.o. and D). In these forms both sides of the mouth are equally and almost symmetrically developed, and the torsion of the head caused by the migration of the upper eye from the blind side has thus had the effect of turning the nasal organ through a right angle independently of the jaws, which have retained their original positions. The dorsal fin does not come so far forward in these as in the other groups, so that the position of the nasal organ has been determined almost solely by the migration of the upper eye. This conclusion is corroborated by what we find in the Lesser Halibut (*Platysomatichthys hippoglossoides*). In this, the jaws are as in the Halibut, but the left eye does not complete its wandering to the upper side. It rests on the ridge of the head, and associated with this the corresponding or left nasal organ remains on the blind side, although close to the ridge.

In the Plaice-group, the mouth is small, and the lower side is much more developed than the upper. There is thus a torsion of the mouth downward, and hence an apparently greater relative torsion of the left eye and, with it, of the left nasal organ upward, from the blind side towards the right or upper side. In reality, however, the nasal organ of the blind side is in almost exactly the same position as in the groups previously mentioned, *i.e.* it is on the median dorsal longitudinal line of the body (Plate XI., Fig. 1, l.n.o.). But the dorsal fin grows forward and inclines towards the blind side of the head as it approaches and passes alongside the eye of that side. The nasal organ of the blind side may therefore be said to be on the upper or eyed side of the dorsal fin (Fig. 1, D, and l.n.o.). In some cases, *e.g. P. cynoglossus*, the nasal organ in question lies obliquely on the ridge anterior to the dorsal fin.

In the Turbot-group the mouth is symmetrical as in the Halibut- and Citharus-groups. There is consequently no torsional influence from this side on the position of the upper or right nasal organ. Hence it is curious to find that, though the torsion of the eye seems to be more complete here than in the other groups, yet the nasal organ is not twisted round so far. This difference has arisen through the great development anteriorly of the dorsal fin. The early stages in development of several species of this group are fairly well known, and it has been repeatedly shown (19, 26, 45) that the dorsal fin grows forward ere the emigrating eye has had time to pass over the ridge of the head. In some cases the anterior extremity of the fin overhangs the eye as it passes the ridge; in other cases the eye seems to pass through the tissues of the base of the fin which has grown so far forward. It is not astonishing, therefore, that the dorsal fin should prevent the complete torsion of the nasal organ of the blind side, although it was not successful in barring the way to the eye. Hence we find that the nasal organ is on the blind side of the dorsal fin (Fig. 3, r.n.o. and D).

In the Sole-group we find a condition of things which almost seems

anomalous. An examination of the skull shows that the distortion of the bones caused by the migration of the eye is quite as complete as in the other forms, yet the parts in connection with the lower nasal organ display no trace of this. Externally we see that the organ of the blind side is in its normal position (Fig. 4, l.n.o.), *i.e.* in a similar position to that of the eye side. It lies a little distance from the extremity of the snout above the maxillary portion of the mouth. This position of the nasal organ of the blind side—which is practically the same in all the species of Soleidæ examined—gives rise to a problem somewhat difficult of solution when we consider that the Soles are descended from one or perhaps two of the preceding groups. If the nasal organ of the blind side in those groups has been carried upward towards the ridge of the head, how has it come about that it remains in its original position in the Soleidæ? The position of the dorsal fin does not afford an explanation, because the development of the fin forwards in the earlier stages of the species whose development is known is just the same as in the Turbot-group. It may be that this organ begins to function very early, and that the underlying structures become disconnected from the parts which are affected by the migration of the eye. This is a problem, however, which can only be solved by a comparative study of the changes in structures that take place during the migration of the eye.

It has thus been shown that the position of the nasal organ of the under or blind side differs in the five groups mentioned. It is probable also that these respective positions will be the same for the species that still remain to be examined.

The position of the nasal organ of the blind side would thus appear to be a character of more than generic importance. In the first four groups its position depends upon the relation between the anterior extremity of the dorsal fin and the migrating eye. The utility of this organ is nevertheless probably equal in all, because the actual position on the head is not very different. And we thus have an example of an important difference arising in one character independently of utility on account of relative alterations in other characters. In the case of the Soleidæ the position of the organ in question is probably connected with its utility. This character is, however, of minor importance in comparison with differences in the internal structure of the nasal organ to be now described. These differences have been already noted by Bateson (6), but as he examined only a few species, it apparently did not occur to him that they were of great importance.

In the Halibut- and Plaice-groups it is found that the olfactory laminæ run parallel to the main axis of the body. The sensory epithelium is simple and comparatively slightly developed, the laminæ being but little raised from the level of the basal supporting membrane (Fig. 5, o.o.). In the Citharus- and Turbot-groups the epithelium is more developed and complex. The laminæ are arranged in the form of a rosette about a median rachis which runs parallel to the main axis of the body. The laminæ are therefore disposed transversely to this axis. In the Sole-group the olfactory organ is similar to that of the Turbot-group, but is not so distinctly rosette-shaped. The laminæ are arranged about a median rachis, but in the form of a leaf in many cases (Fig. 6, o.o.); in other cases the rachis extends the whole length of the underlying membrane, and the laminæ are arranged bilaterally along each side. In the genus *Solea* (Fig. 7) the rachis of the sensory epithelium lies transversely to the main axis of the body, but in other genera *(e.g. Cynoglossus)* the rachis is placed longitudinally, or slightly inclined to the longitudinal axis of the body. In the groups from the Australasian fauna, *Rhombosolea*, etc., and *Brachypleura*, the olfactory

organ is similar to that of the Halibut- and Plaice-groups, that is the laminæ are arranged parallel to the longitudinal axis of the body.

These are the main features of the olfactory organ in the various groups of the *Heterosomata*. Sometimes, however, the epithelium is much degenerated and the number of laminæ reduced. In such cases, *e.g. Scophthalmus*, a reason can usually be found in the habits of species which have altered their sand-loving mode of life to some other where the organ of smell is not of such great necessity. The main features are sufficiently obvious, however, to render possible generalisations and thence a classification based upon this character.

With regard to the nasal sacs which have been described in a previous paper (34), it may be said here that they seem to be special adaptations and are of little importance for classificatory purposes. The nasal organ of the eyed side only need be considered, because that of the other side is distorted by its relationship to the dorsal fin, and the presence of one of the nasal sacs is often doubtful. For the former organ, however, the structures are quite clear. In the Turbot-, Plaice-, and Halibut-groups there are generally two nasal sacs attached to this organ (Figs. 5, 6; l.n.s., r.n.s.). In the Sole-group only one is usually present (Fig. 7, n.s.). Exceptions occur in some of the groups, however, no sacs occurring in several forms, *e.g. Lepidorhombus*, *Pardachirus*, *Rhombosolea*, so that no very great importance can be attached to this character for the purposes of classification.

Pectoral Arch and Ventral Fins.

The arrangement of the bones of the pectoral arch in the *Heterosomata* corresponds to the general Acanthopterygian type. The arch is joined on to the skull by means of the *post-temporal* (p.t.) and the *supraclavicle* (s.c.). The post-temporal has two heads for articulation with the otic region of the skull (*a* and a_2, Fig. 18, Plate XII.), the upper being joined to the *epiotic*, the lower to the *pterotic*. Sometimes it appears as if this bone were formed from two separate ossifications, since it readily separates into two portions in the adult (Fig. 19, p.t. and p.t.), but this occurs very rarely. The *clavicle* (cl.) begins superiorly as a stout rounded bone, but gradually alters its form as it passes the line of attachment with the scapula and coracoid and becomes three-sided—two sides, external and internal, meeting in a prominent anterior ridge, whilst the third, facing posteriorly, is concave. This concavity is more marked in the Turbot-group than in the Plaice- and Halibut-groups, because it continues to the ventral extremity of the clavicle, whereas in the latter groups it gradually decreases until along the line of junction of the one *clavicle* with the other the bone presents only two surfaces, the one facing anteriorly, the other posteriorly. In the Turbot- and also the Sole-group the pectoral arch is more bent or curved anteriorly than in the Plaice and other groups (see Figs. 18, 19, and 20). This is noticeable externally in the forward curvature of the ventral extremity of the pectoral arch in the Turbot-group, and it is worthy of remark that Citharus (Fig. 21) approaches more nearly in this respect, as in many others, to the Plaice- and Halibut-type than to the Turbot (*cf.* Fig. 23). This curvature of the *clavicle* is connected with the position of the ventral fins.

From the inner face of the *clavicle* superiorly arises the *postclavicle*. This is not definitely fixed to the *clavicle* but lies loose in the dermis between the muscles and the skin. It extends posteriorly within the wall of the abdominal cavity as a whip-like bone (Fig. 19, p.c.), and probably has a similar function with regard to the abdominal wall that

the battens in a lateen sail have to the sail. The *postclavicle* is present in the Plaice-, Halibut-, Citharus-, and Turbot-groups, but was not found in any of the species of Soleidæ examined. Cunningham in his "Treatise on the Sole" does not say whether this bone is present or absent.

Along the internal border of the posterior concave aspect of the *clavicle*, the plate of cartilage which gives rise to the *scapula* and *coracoid* is attached. The configuration of these two bones is very similar in all the groups. In the Turbot, only the central portion of the upper plate has become ossified to form the *scapula*. All around it is cartilaginous, even the "brachial ossicles" and the base of the pectoral fin. The degree of ossification is greater on the external surface of these bones, and is greater on the upper or eyed side of the body than on the under. In the Plaice- and Halibut-groups the *scapula* and *coracoid* are firmly ossified and fused together.

The *coracoid* extends downward in a long styliform process which is free and cartilaginous at its lower end. The relation of this process to the *clavicle* is sometimes of great importance in the classification of the Teleostei, but in very few groups of the flat-fishes was any great change noticed. Sometimes the styliform process is broadened out as in Citharus (Fig. 21) and the Soles (Fig. 24), sometimes it seems to be absent, and in a few species of Soles and in *Tephritis* it was found to be attached all along its edge to the *clavicle*.

The bones which have been mentioned do not display any differences that seem of importance for the purposes of classification, though presenting many variations in details. The case is different with the *pubic* bones and position of the ventral fins. The *pubic* arises from the lower posterior surface of the *clavicle*, and may be divided for the purpose of description into two portions. The portion leading down from the clavicle is club-shaped, and of very varying length in different species. It ends inferiorly in a sharp-pointed spine (s., Figs. 18, 19), which is of more frequent occurrence in the Plaice- and Halibut-groups than in the Turbot-group. From the lower third of this club-shaped bone arises anteriorly a thin triangular lamina (l.p.). Sometimes the difference between these two portions of the *pubic* bone is not well marked, as in the Sole-group and individual species of the other groups, but it is convenient to make the distinction. In addition to these two portions there is a third which takes the form of lateral wings near the line where the laminar portion arises. They are prominent in the Turbot (Fig. 19, s.p.), in the Plaice they are compressed alongside the laminar portion (Fig. 18, s.p.), but in many species they are quite absent. These minor differences are, however, insignificant in comparison with the changes in the position of the *pubic* bones relative to one another. In the Plaice- and Halibut-groups the *pubics* run parallel along their whole length. This is also the case in the Sole-group when the ventral fins are symmetrical. In the Turbot-group we find that the club-shaped portion of the *pubic* of the under or blind side tends to lie behind that of the upper or eyed side. In *Arnoglossus* (Fig. 23) the change is not so marked, but in the Megrim, Topknots, and Turbot the former lies completely behind the latter. In *Citharus* we have a transition to what is found in *Arnoglossus*, the club-shaped portion of the *pubic* bone of the eyed side being only slightly anterior to that of the blind side (Figs. 21 and 22).

These differences with regard to the position of the club-shaped portions of the *pubic* bones are accompanied by differences in the structure and position of the laminar portions. In the Plaice- and Halibut-groups these lie wholly behind the base of the *clavicles*, to which

they are attached by a strong ligament. The ventral fins are attached to the bases of the laminar portions, and are directed posteriorly (Fig. 18). In the Citharus-group, we find a similar arrangement (Fig. 21), whether the ventral fins are symmetrical—as in *Paralichthys*, or asymmetrical—as in *Citharichthys*. When these fins are asymmetrical, the laminar portion of the *pubic* bone of the upper or eyed side is attached to the base of the *clavicles* (Fig. 21, v.l.). In the Sole-group when the ventral fins are symmetrical, the clavicles are short and do not extend to the ventral edge of the body. In this case the *pubics* are suspended from near their base, and the ventral fins, though posterior to the *clavicles*, have no direct connection thereto (Fig. 24). On the other hand, the Turbot-group, as already noted in the "*Scandinavian Fishes*" (p. 426), shows a remarkable difference from the above groups in this respect. Beginning with *Arnoglossus* (Fig. 23), we find that the laminar portion of the *pubic* bone of the eyed side is continued forward anteriorly beyond the base of the *clavicles* by a cartilaginous plate (V.l.). That of the blind side has no cartilaginous plate, and stops short at the base of the *clavicles* (V.r.) In the Turbots this cartilaginous plate is present on both *pubic* bones. These plates are closely and firmly approximated to one another on their inner surfaces, and both extend beyond the base of the *clavicles* as far as the anterior extremity of the lower prong of the *urohyal* (Fig. 19, u.). According to the description in the work cited, this cartilaginous plate is a part of the triangularly-shaped laminar portion of the *pubic*. This is not exactly the case, however. The cartilage is surrounded by an outer hard layer, but one can readily detect its line of fusion with the osseous *pubic* (Fig. 19, c.V. and l.p.). The rays of the ventral fins arise from the ventral edge of the cartilaginous plates, and are thus morphologically distinct from those of the previous groups. These plates further have no attachment to the clavicles, and depend solely from the pubics and *urohyal*.*

The presence of these plates of cartilage affords a prolonged base of attachment for the fin-rays, and we consequently find that in this case the ventral fin-rays are more spread out and thicker than in the groups where the cartilage is absent.

When only one cartilaginous plate is developed, the ventral fin of that side is prolonged anteriorly much in advance of that of the other side. When both plates are developed, the rays of the one fin alternate with those of the other fin, as in the Turbot. The fin which is anterior is generally that of the upper or eyed side, but according to the American writers the reverse is the case in *Hemirhombus* (*Syacium*).

These differences of internal structure in the various groups show themselves in marked differences externally. In the Plaice- and Halibut-groups, as also in the genus *Solea*, the ventral fins are symmetrical with regard to one another and to the ventral line of the body. In the Turbot-group they are clearly asymmetrical. In *Citharus*, with its allies *Citharichthys* and *Hemirhombus*, the ventral fins are also asymmetrical, but it is necessary to note an important difference between this asymmetry and that of the Turbot. In the former the cartilaginous plate is absent and the fins are both behind the base of the *clavicles* (Fg. 21), in the latter the reverse is the case. The ventral fins in these two groups are therefore morphologically distinct in spite of the asymmetry being present in both, and this important difference gives a means of forming a new sub-family of the flat-fishes with *Citharus* as the type.

* Cunningham (9) has proposed to call this bone *jugular*, because of its remote position from that usually occupied by the *urohyal*. Although its form and position are not the same, yet its relationships are similar—in that it is a median bone in line posteriorly with the *glossohyal*, forming the isthmus between the branchial cavities and connecting the pectoral arch with the hyoid bones. One is therefore justified in calling it the *urohyal*.

The bone in front of the clavicle to which the laminal cartilage of the ventral fins in the Turbot-group is attached requires special mention, as it seems to have a special importance in the flat-fishes. Its form is that of a two-pronged fork, the base of which rests on the *clavicle*, the upper prong passing forward into the substance of the tongue, and the lower shorter fork bending obliquely downward and forward. In the Turbot-group this latter prong is directly connected with the ventral fins, in the other groups mentioned above it has no such connection, but a ligament passes from its end to the end of the *clavicle* and thence to the base of the ventral fin. It would seem to have an important physiological significance, more especially in the Turbot-group, where the bone is larger than in the other groups. It acts as a lever, the clavicle acting as fulcrum, so that any movement of the fins which affects the lower prong will also affect the upper, and thence also the tongue and branchiostegal apparatus, the size of the mouth being thus affected. It is interesting to note further that in the specialised rhomboid-forms, the Topknots, the ventral fins are relatively nearer the mouth than in the other forms, and this is connected with the more anterior position of the *pubic* bone (Fig. 20). The habits of these forms are also specialised, for, as shown by Cunningham and others, these fish swim, or rather hang suspended in a vertical position, amongst the seaweed or rocks, and may use the ventral fins to keep themselves in position.

Vertebral Column and Alimentary Canal.

The formation and arrangement of the vertebræ and vertebral processes furnish important evidence of affinities within the various groups of flat-fishes, much more so than in the round-fishes. The vertebræ are divided into two classes—abdominal and caudal, the differences between which are generally well marked. The former possess certain processes projecting laterally and ventrally on each side, and called *parapophyses* by Günther, to which primary and secondary ribs are attached. In the caudal region the *parapophyses* have joined ventrally to form the *hæmapophyses*, which resemble greatly the *neurapophyses*. According to Günther, the abdominal region ends and the caudal region begins with the first vertebra bearing the hæmapophyses.

This distinction between the vertebræ applies generally amongst the round-fishes, and also in the least specialised of the flat-fishes, *i.e.* in the Halibut- and Plaice-groups. The abdominal vertebra, in addition to the neurapophyses, is provided with ventrally projecting parapophyses, to which are attached the primary (*cf.* Fig. 11, p.r.) and secondary ribs (s.r.). The secondary ribs are short, and arise from the anterior vertebræ. The primary ribs are long, and extend posteriorly and ventrally, those of the posterior abdominal vertebræ reaching as far as the first interhæmal spine. This spine lies along the anterior surface of the first hæmal process, and thus corresponds to the beginning of the caudal vertebræ. These latter have the ordinary structure, and are usually provided with more or less prominent transverse processes.

A similar disposition of the vertebræ is found in the Turbot, but its other characters show this form to be highly specialised, and it is probable that this disposition has arisen secondarily, *i.e.* has reappeared after passing through a certain transitional stage. The reason for this statement is that the forms which stand between the Turbot and the most primitive group of flat-fishes have a different arrangement of the vertebræ. In these, *Citharus*, *Arnoglossus*, and *Rhomboidichthys*, the last three to six abdominal vertebræ bear short hæmapophyses and transverse processes (Fig. 11), which replace the parapophyses and primary

ribs. The secondary ribs arise from the transverse processes or the neural arches. Beginning from the second abdominal vertebra—sometimes they appear to be present on the first, they arise from the neural arches, then their points of origin pass on to the centrum, until on the seventh or eighth vertebra they arise from transverse processes which are placed more to the ventral than dorsal surface of the vertebra. In *Citharus*, the secondary ribs are continued on to the caudal vertebræ. This disposition of the vertebræ was remarked by Costa (8) in *Rhomboidichthys*, and he classified them into three—*cervical*, *dorsal*, and *caudal*, by analogy with the terms employed for higher vertebrates. These terms are obviously misleading, because we should then have ribs on the *cervical* vertebræ, and it is better to call the vertebræ which form the dorsal wall of the abdominal cavity abdominal, and to subdivide them when necessary into those with hæmapophyses and those without.

According to Günther's definition (21), the caudal region would begin with the first vertebra which bears the hæmapophyses. According to this the abdominal cavity in the above species would be limited to the first four to six vertebræ from the skull, whereas it is in reality prolonged much further back. A better sign of the delimitation of the abdominal cavity and of the commencement of the caudal vertebræ in the above species, as in the groups previously mentioned, is the first interhæmal spine. This is large, and forms the posterior boundary of the abdominal cavity.

Arnoglossus and *Rhomboidichthys* form a good example of the value of this character for classification. Formerly these were separated from one another, and *Arnoglossus* was considered to be more closely related to *Lepidorhombus* (13). More recently (50) the latter has been placed along with the Topknots, and the two former brought close together under one genus (*Platophrys*), in spite of the great external differences between them. As mentioned above, *Arnoglossus* and *Rhomboidichthys* have a similar arrangement of the vertebræ. *Lepidorhombus*, on the other hand, is like the Turbot and Topknots in this character, and is therefore widely removed from the two former. In another important character, viz. the ventral fins, *Arnoglossus* and *Rhomboidichthys* are also connected and different from the other genera of the Turbot-group, so that their characters are very clear and definite.

The arrangement of the vertebræ which is found exceptionally in the Turbot-group becomes the rule in the Sole-group. Both in the *Cynoglossinæ* and the true Soles, all the species examined showed the *hæmapophyses* in the abdominal vertebræ. These *hæmapophyses* are relatively much shorter than those of the caudal vertebræ, and in *Solea* (Fig. 9) there is a gradual transition from the one to the other.

In addition to the differences in the formation of the abdominal vertebræ in the various groups, there are also important differences in other characters connected with the abdominal cavity. The first interhæmal spine which forms its posterior boundary is large and strong in the Plaice- and Halibut-groups, extending in a groove along the first spine almost to the centrum of the first caudal vertebra. The outer end of this spine is very sharp, and may even project through the skin. This character—the presence of an "anal spine"—is employed by Günther and the American writers as a specific character, but the appearance of the spine externally may depend greatly on the condition of the specimen. Thus Günther declares that there is no anal spine in the Long Rough Dab (*D. platessoides*), whereas the American writers say there is. The latter again declare that *P. cynoglossus* has an anal spine, whilst *P. microcephalus* lacks it, and both they and Günther state that there is no anal spine in the Halibut. As a matter of fact the first inter-

hæmal spine is strong and well developed in all these species, and the appearance of the outer point externally cannot be relied upon.

In the Citharus- and Turbot-groups the first interhæmal spine is also large and well developed (Fig. 8), but in *Rhomboidichthys* it extends only half-way along the hæmal spine, and in *Citharus* but a little further. The outer end of the interhæmal spine, however, lies some distance within the skin, and is continued forward by partly ossified plates of cartilage (Fig. 8, c.), from the ventral edge of which the interspinous rays arise which support the anterior rays of the anal fin. There can be no chance, therefore, of an "anal spine" appearing externally. In the Sole-group (Fig. 9, i.s.) the first interhæmal spine is much reduced, and arises from near the end of the first hæmal spine. In place of the one interhæmal spine of the previous groups, in the Sole-group there are four or five. These are not prominent externally, and thus present no anal spine.

The remaining groups of the flat-fishes, those of the Australasian fauna, have not yet been so carefully examined with regard to these characters. In *Rhombosolea* and *Brachypleura* the arrangement of the various structures is the same as in the Sole-group; the last four to six abdominal vertebræ bear hæmapophyses, and the first interhæmal spine is slender and little developed. It is most probable that this arrangement is the same in the other forms, *Ammotretis* and *Peltorhamphus*, because the external configuration of the abdominal cavity is similar.

It appears, therefore, that the presence of hæmapophyses on the abdominal vertebræ is a valuable character for displaying affinities. These are found universally amongst the Soleidæ, and in certain genera of neighbouring groups. From their presence in the latter we may conclude that these genera have a certain relation to the Soleidæ closer than that possessed by the remaining genera of the same groups.

An example has already been given of the utility of this for purposes of classification. When more genera of the Citharus-group have been examined, this character may again be of use in aiding to subdivide this group. It also aids in differentiating the group of flat-fishes in the Australasian fauna from the Plaice-, Halibut-, and Turbot-groups within which they were formerly placed.

With regard to the *alimentary canal*, the differences found in the various groups are connected with two characters: the intestine—its increase or decrease in length, and the pyloric cæca—their presence or absence. The increase in length of the intestine is chiefly well-marked in the Sole-group and in one or two forms which in some way resemble the Soles, *e.g.* the Lemon-sole *(P. microcephalus)*. In these, two to four coils of the intestine lie along the interhæmal spines of the eyed side, within the secondary body-cavity, which contains also the reproductive organ of that side. This occurs in many other forms, *e.g. Rhomboidichthys*, Plaice, etc., but not to the same extent, the intestine merely projecting into the second body-cavity. It may be that the projection of the intestine into the latter cavity has the advantage of protecting the kidney from injury. In the Sole-group, for example, owing to the presence of *hæmapophyses* on the posterior abdominal vertebræ, the primary abdominal cavity is very small, and some compensation for this is therefore necessary. In the Lemon-sole, although *hæmapophyses* are not present on the abdominal vertebræ, the increase in length of the intestine alone has rendered it necessary apparently to have more room than the primary abdominal cavity can give. On the other hand, this compensation may be obtained by the reduction in length of the intestine. Such is found in *Citharus*, for example, where the posterior abdominal vertebrae bear *hæmapophyses*, but where the intestine is very short.

As an additional protection to the kidney in *Citharus*, we find that the primary ribs of the abdominal vertebræ anterior to those bearing *hæmapophyses* are prolonged greatly posteriorly and ventrally over the *hæmapophyses* and enclose the kidney.

This character very evidently marks a specialisation in structure and habits and cannot be used in classification. Such is the case also with the pyloric cæca. As mentioned by Sagemehl, these vary in a strange and at present unaccounted-for manner even in such as the Clupeidæ and Salmonidæ. In the *Heterosomata* four seems to be the maximum number, but there may be none at all. In the Plaice-group, two, three, or four may be present; four are found in the Halibut, *Rhomboidichthys*, and *Pseudorhombus*; whilst none are found in *Psettodes*, *Rhombosolea*, and possibly many more. *P. cynoglossus*, on the other hand, is similar to the Plaice in this respect. The only group in which this character seems to be constant is that of the Soles, and here there are none at all. As these cæca are in most cases small it is sometimes difficult to say whether slight protuberances or swellings on the intestine are worthy to be called cæca or not, and this occurs in *Citharichthys*, *Parophrys*, *Brachypleura*, and possibly many more. These seem to represent the transition-stages between the presence and absence of the cæca.

Hypural Elements.

The terms by which the bones of the posterior region of the vertebral column are described have been fixed by Huxley (25). The broad fan-shaped bone continuous with the vertebral column is the *hypural* bone (hy.[1], Figs. 13-16). Dorsal and ventral to this are two bones which are very similar in appearance, but very dissimilar in their relation to other structures. The dorsal wedge-shaped bone has developed in connection with the *urostyle*, the ossification which supersedes the termination of the notochord, and is dorsal to it, as is shown clearly in the case of the Sole (Fig. 16). Hence this should be called the *epiural*, according to Huxley's terminology. The ventral wedge-shaped bone has no such relations, however, and is not dignified by any other name than *hypural*, but in order to distinguish it from the above it may be called the *second hypural* (hy.[2]). The relationships of these bones to one another, and to the spines of the second-last vertebra, are not always the same in the various groups of flat-fishes. The fan-shaped hypural bone in the adult is divided into two portions which may be quite separate from one another, but are as a rule joined by a thin connecting layer of bone. The mark of division is not quite in the median line, but inclines slightly downwards, so that the ventral portion is smaller than the dorsal. The distal end is marked by furrows and ridges—the latter being in line with the caudal fin-rays, whilst the furrows pass backward towards the centrum of the last vertebra to a varying extent, some going almost the whole length, others only a little way. The furrows are ossified superficially only, the internal structure being cartilaginous, so that a large amount of flexure is possible. The second hypural and the epiural are similarly furrowed.

The number of ridges and furrows varies, of course, in the different species, but if only the Plaice-, Halibut-, Citharus-, and Turbot-groups be considered, it will be seen that there is no essential difference between them. According to Sauvage (47), three types or three forms of hypural structures were to be found in the flat-fishes—the one, Plaice- or Pleuronectid-type, in which the hypural bones were completely ossified; another, Turbot-type, in which the hypural bones were divided into separate rays to support the caudal fin-rays; and a third type, in the

Soles, in which the rays were only partially united. It was remarked by him also that the appearance of the flat-fishes in the geological records corresponded with these differences. The Turbot-group with free supporting rays appears first in the Tertiary period, the Solea next, whilst the Plaice-group is essentially modern. Such a correspondence would be of great interest, suggesting, as was pointed out by Sauvage, the possible lines of descent; but it does not seem possible to retain the distinctions made. All the species of the Turbot-group which have been examined resembled those of the Plaice- and Halibut-groups in having the hypurals as ossified plates and not composed of separate rays. In some cases, indeed, *e.g.* the Turbot itself (Fig. 14), the hypurals and epiural are fused into one piece, where ordinarily they are divided into three (Fig. 13, ep., hy.^{1}, hy.^{2}). When dried specimens are examined, however, the ossification along the furrows shrinks considerably, because the internal tissue is cartilaginous along these lines, and the ridges become more prominent. The only explanation, therefore, of the facts described by Sauvage is that he has examined dried specimens of the Turbot, and possibly spirit or fresh specimens of the other species. These furrows contract within a few hours, if left to dry, and also in spirit to a certain extent, so that it is advisable to make comparisons with specimens which are under similar conditions.

The bones composing the element supporting the caudal fin-rays are made up chiefly by the three already mentioned, but two or even three others may also take part. The neural and hæmal spines of the second-last vertebra aid invariably in the groups mentioned in supporting the caudal fin-rays. Sometimes they seem to be furrowed like the hypurals, but this has probably arisen from the fusion of a separate and secondary ossification with the true spine, as shown in the drawings of Soles and Turbot (Figs. 14 and 15). Sometimes the hæmal—but not the neural—spine of the third-last vertebra also develops so far posteriorly as to support the first ray of the caudal fin on the ventral side. The extra development of this spine over that of the corresponding dorsal makes up for the greater relative development of the dorsal half of the fan-shaped hypural, and makes the number of fin-rays equal on both sides of the median line.

The basal elements of the caudal fin are thus essentially the same in the Plaice-, Halibut-, Citharus-, and Turbot-groups, and this might have been expected beforehand from a survey of the other parts of the skeleton. In comparison with the Soles, the skull and body-skeleton of these groups are massive, and the movements and habits of the animals consequently require a strong and powerful tail, and thus a strong supporting structure. In the case of the Soles, the skeleton is not so massive, nor do the animals grow to the same size as in the other groups. We thus find in them a transition to a totally different type of structure. In the true Soles (Fig. 15) there is little apparent difference superficially from the Turbot and other groups. The hypurals are marked by furrows and ridges, and the spines of the second and third last vertebræ also take part in supporting the caudal fin-rays. But the urostyle (Fig. 15, u.) remains short and distinguishable from the epiural, whereas in the previous forms it was indistinguishable. This decrease in size of the urostyle becomes greater in the more specialised genera of the Sole-group, and is accompanied by a reduction in the hypural bones, until in the most specialised, as in *Ammopleurops* (Fig. 17) and *Cynoglossus*, we obtain a semblance of the diphycercal tail. How this change has taken place—whether the posterior vertebræ in such as *Ammopleurops* (Fig. 17) are not really homologous to vertebræ, but have arisen from modifications of the hypural elements, or whether the

primitive notochord proceeds to the extremity of the caudal region as in the true diphycereal tail—it is impossible to say until the developmental stages are examined. If the former were the case, however, we should expect to find some evidence of the urostyle amongst the posterior vertebræ, but there is no trace of it. Hence we should be inclined to believe that the true form of the diphycercal tail reappears again through convergency. The gradual transformation which is undergone by the urostyle is evidence for this view. Only one stage is here represented, that in Soles (Fig. 15, u.), but an analogous phenomenon is found amongst the eels. Ryder (46), in his treatise on this subject, gives a drawing (Plate IV., Fig. 4) of the caudal region of the Common Eel, which might well represent a further stage in the specialisation of the flat-fishes to that shown here in Soles. The end of the notochord is only slightly bent up, and is almost in line with the other vertebræ. The diphycercal form is obtained further in *Muræna*, which may be compared with *Ammopleurops* and *Cynoglossus* amongst the flat-fishes. It is possible, therefore, that we should call the last degree of specialisation in these fishes the true diphycercal form, and not "pseudodiphycercal" as was formerly suggested.

The development of the caudal region in the flat-fishes has been described by Agassiz (4), M'Intosh and Prince (38), and other writers, but for somewhat earlier stages than those required for the present purpose. It seems clear, however, that Cunningham's view that the hypural bone represents the ventral spines of a number of vertebræ fused together (9, p. 39) is quite erroneous, and that the conclusions of Huxley (28) and Ryder (46) for other forms hold good also for the flat-fishes. In Fig. 16 is shown a drawing of the posterior caudal region of a post-larval Sole 13mm. in length. The hypural elements which later develop into the fan-shaped bone (Fig. 15, hy.[1]) are not yet fused together, but appear as four separate and distinct plates. Their form and position show that they rather correspond to interspinous elements than to hæmal spines. Inasmuch as they fuse later, however, to the base of the urostyle, and support distally the caudal fin-rays, we may accept Huxley's conclusion that they are really composed of both hæmal and interhæmal elements.

From the foregoing description of the caudal region it will be concluded that the diverse forms and changes in structure which are found amongst the flat-fishes may be of use as showing various stages in specialisation, and thus of showing affinities between species in certain groups, but do not aid in the general work of classification, as was imagined by Sauvage. Only with the Soleidæ do they become of such use, because in the other groups the form and structure of the caudal region are essentially the same, and even in the Soleidæ so little is yet known of the intermediate stages between the true Soles and such as Cynoglossus that no classification based on this character could be proposed.

Characters of Most Importance for Classification.

We may once again pass under review briefly the characters which have just been described, in order to consider their respective merits for the purposes of classification. Only those which gave promise of being of importance have been mentioned here, and the choice of characters is therefore not a large one. In a work such as this, further, which endeavours to group the various genera according to their natural affinities, it is self-evident that not one character alone but several must be chosen. So long as the number of species known was relatively small, and classifiers wished to have some external character or

characters which would enable them to locate readily any new specimen which came to hand, a classification based on one character was for the most part sufficient and satisfactory. The aim of the classifier was then to find out that external character which most clearly marked off one group consisting of many species and genera from another such group, and it has already been mentioned that no wider-reaching or more general external character could have been found for the separation of the *Heterosomata* into groups than that chosen by Günther, namely, the size and structure of the mouth. Even this, however, shows the weakness of a one-character classification, because the Soles had to be left to one side as an ill-defined heterogeneous group containing both small- and large-mouthed species. Other similar classifications suffer from similar defects. The best classification of the *Heterosomata* hitherto—that, namely, of Jordan and his collaborators—chooses the symmetrical or asymmetrical position of the ventral fins with respect to the median ventral line of the body as the chief character differentiating the Turbot- from the Halibut- and Plaice-groups. But it has already been shown in this paper, and it will be referred to again later when discussing the various groups, how this external difference — viz., symmetry or asymmetry—depends upon certain differences in the arrangement of the underlying structures, and how there are various intermediate stages from the one arrangement to the other; so that a form, *e.g. Citharus*,* may have the ventral fins slightly asymmetrical and yet be more nearly related to the symmetrical group of flat-fishes. Hence, even with this character, we soon stumble upon difficulties. The Plaice- and Halibut-groups are certainly well marked off from the Turbot- and all three from the Sole-group by its means, but a difficulty arises when we wish to find the limit between the Halibut- and Turbot-groups. All intermediate stages from the symmetrical condition of the Halibut- to the asymmetrical of the Turbot-group are present, and we should be quite at a loss in fixing the limit between them, even though the representative species in the intermediate stages are few in number, if we could not call in the aid of another character. This further character is the form and structure of the olfactory epithelium. By means of this character the Halibut-group is even more sharply divided from the Turbot-group than by the former, and it is found that the intermediate stages between these two groups, though more nearly related to the Halibut than to the Turbot in regard to the structure and position of the ventral fins, have the same type of olfactory organ as the Turbot. The genera possessing the combination of these two characters are consequently separated from both the Halibut- and Turbot-groups and placed in an intermediate sub-family.

It might be thought that the structure of the olfactory organ was a character of greater importance than the position of the ventral fins for the purposes of classification. Such is not the case, however. There are in reality only two types of olfactory organ—the one with the sensory epithelium arranged linearly in longitudinal lamellæ, the other with this epithelium in the form of a rosette. The different forms which are found in the Soleidæ are but varieties of the latter type. Hence, if we choose this as the chief character, we shall be obliged to classify the *Heterosomata* into two sharply-divided groups, each of which contains a number of genera at some distance from their natural allies. This will be displayed in more detail when the characters of the various groups are considered with regard to their distribution. It may be mentioned, further, that the sensory epithelium of the olfactory organ

*Even in *Paralichthys*, which has a close superficial resemblance to the Halibut, the ventral fins are not exactly symmetrical, thus furnishing an additional reason for grouping this genus with *Cithurus*, *vide* pp. 354-356.

shows a tendency to degenerate in several species and genera, *e.g. Scophthalmus*, so that this character cannot always be relied upon with certainty.

Similar difficulties arise with the other characters which have been described. Each by itself is able to give some sort of classification, but the genera are then arranged merely according to their resemblance with respect to these characters and not necessarily according to their natural affinities. Thus we should obtain different combinations of the *Heterosomata* if we arranged the various genera according to the size and structure of the mouth, or according to the structure of the abdominal or of the last caudal vertebræ, and so on, just as the classifiers of the *Heterosomata* hitherto have done, and one combination would be as good as the others. Each of these characters would divide the *Heterosomata* into two or three large groups, but the lines of division would differ in the different combinations. They are too general, making no allowance for the results of convergency, and do not permit of fine transitional stages being displayed. When, however, they are taken along with the two characters which have been mentioned above, the position of the ventral fins, and the structure of the olfactory organ, they furnish important evidence for the further division of the various groups.

Apart from the particular problems which arise in endeavouring to fix the details of each group, and which will be considered later, there are still a few general questions to be answered. It has been shown repeatedly that what is best for the purposes of classification is not necessarily the best for showing natural affinities, and the question thence arises— Can any classification truly represent the natural affinities of the species classified? In theory the answer is simple, because the classification that will receive the most respect is the one which displays in a simple and natural manner the groupings of the various species as we find them in nature. In practice, however, there are certain unwritten laws according to which a classification should be formed. It should be clear, not cumbered with too many details, and such that any specimen examined may be readily located. Such have been the prevalent notions hitherto, and a conflict thence arises between practical expediency and theoretical correctness. Recent opinion, however, as shown in the work of the American writers, has tended strongly in favour of the latter. The work of Jordan and his collaborators has shown clearly in its various developmental phases that, after all, several different classifications would suit the demands of practical expediency, and the chief value of their last great work (33), for the *Heterosomata* at any rate, is that it has passed beyond this stage and really endeavours to display the natural affinities of the various species, genera, and groups.

The second and more serious question that then arises is whether the characters presented to us—such as have been described here—are really capable of displaying affinities. In these days of the study of variations, when the older notions of the value and fixity of heredity are being rudely shaken, we are not inclined to believe in the permanence, or even comparative permanence, of any character whatsoever. May not, then, the complex condition of things in the environment with the flexible nature of habits have so reacted on the plastic structures that all the lines of genetic relationship are woven round and round inextricably into the form of a net or huge tangle, and any chance of finding a "phylogenetic tree" thereby rendered hopeless? In the case of a large group of animals, such as the Fishes as a whole, or of the *Teleostomi*, one might assent to this, and agree also with Sagemehl that even for a

small group, such as the Siluridæ and their nearest allies, only those characters which were out of the common, *e.g.* the Weberian ossicles, or those which were little employed and were thus little acted upon by the strong hand of the environment, such as the bones of the pectoral arch, could be relied upon in the least to show genetic affinities. Nevertheless, there is good reason for believing that the flat-fishes form a favoured group. As a whole they are well marked off from all other groups of the Teleostei, even from the Gadidæ, to which they are supposed to be most nearly related, and this sharp demarcation displays a fact which is very evident throughout—viz., that the group is specialised from the very beginning. The habits and habitat of the species included under it are also peculiar and in certain ways quite uniform throughout the group. We should expect, therefore, that this uniformity will display itself in a certain amount of constancy in the characters, and that if these latter change they will do so in accordance with certain well-marked differences in the surrounding physical conditions, or to greater specialisation of habits and habitat. The former element is shown in the geographical distribution of the characters of the various sub-groups or families; the latter, in these characters also to a certain extent, but more especially in those of the species within the separate sub-groups or families. It follows from this that a classification of the flat-fishes, if it is intended to represent the genetic affinities of the various divisions, should display, along with the characters, their distribution generally and their varying degrees of specialisation. This, in truth, seems possible for the *Heterosomata*, and in the following pages the endeavour is made to show in general outlines how such a classification may be realised. The influence of convergency can also be seen in the various groups, but only the more general and outstanding examples need be mentioned.

Classification of the *Heterosomata*.

Families.

a. Preopercular margin more or less distinct, not hidden by the skin and scales of the head.

Pleuronectidæ.

α. *Hippoglossinæ* (Halibut-tribe).
β. *Pleuronectinæ* (Flounder-tribe).
γ. *Psettinæ* (= *Bothinæ*) (Turbot-tribe).

aa. Preopercular margin aduate, hidden by the skin and scales of the head.

Soleidæ.

α. *Achirinæ* (American Soles).
β. *Soleinæ* (European Soles).
γ. *Cynoglossinæ*.

The above classification, with slight modifications, is taken from the recent work of Jordan and Evermann (33). It is the most convenient at the present time for grouping together the flat-fishes as a whole, but one feels already that it is too definite and cramping to express well the relationships of the various groups to one another. It is premature, for much yet requires to be known, to endeavour to substitute this scheme by another, but it is thought advisable to present the various groups in the following loose arrangement, which has the double advantage of displaying affinities, and at the same time of showing the gaps in our knowledge.

Families.	*Sub-families.*
Pleuronectidæ	*Hippoglossinæ.*
	Pleuronectinæ.
	Hippoglosso-rhombinæ.
	Rhombinæ.
Soleidæ	*Soleinæ.*
	Achirinæ.
	Cynoglossinæ.
Solei-pleuronectinæ.	
Incertæ sedis ?	

Sub-Fam. *Hippoglossinæ.*

(1) Preopercular margin distinct, not hidden by the skin and scales of the head.
(2) Olfactory laminæ arranged longitudinally with median rachis.
(3) Ventral fins placed symmetrically about ventral line of body, the pubic bones being wholly behind the base of the clavicles and connected thereto by a ligament.
(4) Nasal organ of blind side lies anterior to the anterior extremity of the dorsal fin on the ridge of the head.
(5) Mouth nearly symmetrical, the dentition nearly equally developed on both sides; gape large; lower jaw most prominent.
(6) Eyes on right side, large.

This sub-family, restricted by the above characters, includes the following genera :—

Species Examined.	*Genus.*	*Distribution.*
A. stomias . . .	Atheresthes, Jordan and Gilbert.	Bering Sea to San Francisco.
P. hippoglossoides . .	Platysomatichthys, Bl.	Arctic parts of the Atlantic.
H. vulgaris . . .	Hippoglossus, Fl.	North Atlantic and North Pacific
(?)	Lyopsetta, Jordan & Goss.	California and North Pacific.
(?)	Eopsetta, „	
D. elassodon . .	Drepanopsetta, Gill.	North Atlantic and North Pacific
D. platessoides .		
P. melanostictus . .	Psettichthys, Girard.	Pacific coasts of North America.
	Verasper, Jordan & Gilbert.	Japan.
(?)	Hippoglossina, Steindachner	Pacific Coast — California to Mexico.
(?)	Lioglossina, Gilbert.	California
(?)	Xystreurys, Jordan and Gilbert.	South California.

The last three genera are placed as doubtful because they may belong to the family of the Hippoglosso-rhombinæ. They are said by Jordan to be closely related to *Paralichthys*, and this, along with their southerly distribution, their tendency to be either sinistral or dextral—a characteristic of the Hippoglosso-rhombinæ—raises the doubt as to whether they should be grouped with the Hippoglossinæ or with the latter group. It is possible, also, that *Verasper* should accompany the other three genera.

This family includes *Atheresthes* and *Platysomatichthys*, which are generally believed to be more closely related to the primitive ancestors of the *Heterosomata* than any of the other species. The evidence on which this is based rests almost entirely on the position of the left eye,

i.e. the eye of the blind side, which is on the ridge of the head, looking almost vertically upwards. This position, which appears to be the normal one, recalls the abnormal specimens of other species with arrested migration of the eye of the blind side which are sometimes found, *e.g.* Turbot. Whether these two species are in reality the nearest modern representatives to the primitive ancestors, or whether they are specialisations just as *Cynoglossus* of the Soleinæ is a specialisation at the other extreme, it is impossible to say. In the present paper, however, it is assumed that they are the most primitive forms, and hence the Hippoglossinæ form the earliest or first family of the *Heterosomata*.

The distribution of the various genera here included under the Hippoglossinæ is noteworthy. They all belong to the Arctic and northern portions of the temperate regions.

Sub-Fam. *Pleuronectinæ*.

(1), (2), (3), as in Hippoglossinæ.

(4) The anterior extremity of the dorsal fin is inclined towards the blind side of the head, and lies posterior to the nasal organ of that side, which is (usually) on the ridge of the head.

(5) Mouth unsymmetrical, dentition more developed on blind side; gape small; under jaw more prominent.

(6) Eyes on right side as a rule, large.

The following genera are included under this sub-family :—

Species Examined.	*Genus.*	*Distribution.*
P. cornuta . . .	Parophrys, Gtr.	North America and Japan.
	Pleuronichthys, Girard.	North Pacific.
(?)	Inopsetta, Jordan and Goss.	Pacific coasts of North America.
(?)	Isopsetta, Lockington.	
Lepidopsetta bilineata .	Lepidopsetta, Gill.	
L. limanda . .	Limanda, Gottsche.	North Atlantic and North Pacific.
L. aspera . .		
(?)	Liopsetta, Gill.	North Atlantic and North Pacific (American).
Platichthys stellatus .	Platichthys, Girard.	North Pacific.
P. flesus . .	Pleuronectes, L.	North Atlantic and North Pacific.
P. platessa . .		
P. microcephalus		
P. cynoglossus .		

Various other genera are included by Jordan within this family, but since they are generally classified by other writers as species under the above genera, it is considered advisable to omit them for the present. For example, *Pleuronectes microcephalus* has been relegated to a new genus, *Microstomus*, and *P. cynoglossus* to another, *Glyptocephalus*. Examination of the internal structure of the former species shows that it is very closely allied to the plaice, *P. platessa*, even to the presence of the characteristic tubercles on the otic regions of the skull. *P. cynoglossus* seems the next step to *P. microcephalus* in the specialisation away from the Plaice, and it is a pity to subdivide these species into separate genera when their inclusion within one genus more fitly expresses their affinities.

This sub-family is well marked off from the preceding, to which it is most nearly allied, and from which it has probably been derived, by the peculiar shape and size of the mouth. Amongst the European forms there seem to be no transition stages, but amongst the American Jordan mentions that *Isopsetta* closely resembles *Psettichthys* of the family of Hippoglossinæ.

It is probable, therefore, that the transitional forms existed in the European waters at one time, but have now disappeared. On the other hand, in the peculiar shape of the mouth and in the presence of the "Sole-form" in such as *P. microcephalus* and *P. cynoglossus* we see the close affinities of this family to the Soleinæ—not that these are necessarily the forms which mark the transitional stages, but they indicate how the Soleinæ might have been derived from the Pleuronectinæ.

The distribution of the genera included within this family is more southerly than that of the Hippoglossinæ, but they are for the most part confined to the more northerly portions of the temperate zone.

Sub-Fam. *Hippoglosso-rhombinæ.*

(1) As in Hippoglossinæ.
(2) Olfactory laminæ arranged transversely about a median rachis.
(3) Ventral fins varying from the symmetrical condition of the Hippoglossinæ to a partial form of the asymmetrical condition in the Rhombinæ; in all, the pubic bones are wholly behind the clavicles, to which, when the fins are asymmetrical, the anterior of the pubic bones is sometimes attached.
(4) As in Pleuronectinæ, but the anterior extremity of dorsal fin is continued forward in some genera to nasal organ of blind side.
(5) As in Hippoglossinæ.
(6) Eyes on left side as a rule, but very variable, large.

These are the characters which unite together a number of genera some of which have been hitherto classed with the Halibuts, and others with the Turbots. They are separated from the former group by having the form of olfactory organ which is found in the latter, whilst they are more akin to the Halibut-group in almost all other characters. The genera which have hitherto been included with the Halibut-group are *Paralichthys*, *Pseudorhombus*,* *Psettodes*, and *Tephritis*. These are evidently distinguished from the Halibuts by character (2), in that they have the olfactory laminæ arranged transversely about a median rachis. The most remarkable form is *Psettodes*, which has hitherto been classed with the Halibuts and considered to have affinities to the most primitive, viz. *Atheresthes*. These affinities, displayed in the general form and structure and in teeth, are certainly striking, and lead to the conclusion that *Psettodes* is either a direct offshoot from the Halibut, or, if it has come through any intermediate forms, that it has assumed these characters by specialisation to its peculiar habits of life. The structure of the olfactory organ, however, seems a sufficient reason for removing this genus along with *Paralichthys* from the Halibut group and placing it in this family. In addition to the structure of the olfactory organ, there are other characteristics which separate it from the Halibuts. In the Halibut-group the eyes are almost invariably on the right side. In this genus, as in the other genera of this family, the eyes may be on the left or right side, but generally on the left. Thus, of nine examples mentioned by Günther in his Catalogue (vol. IV., p. 402), five had the eyes on the left side, four on the right. The specimen examined by myself, further, had no pyloric cæca—a characteristic of the Sole-group. Lastly, the distribution of this genus is southerly, where that of the Halibuts is northerly, as already noted.

With regard to *Paralichthys*, there is less objection to removing it from the Halibuts than there is with *Psettodes*. With the exception of

* The American writers include *Pseudorhombus* under *Paralichthys*.

the relatively slight difference in the position of the ventral fins and the form of the lateral line, the description given by the American writers for this genus (33, p. 2624) agrees exactly with that given for *Citharichthys* (*ibid.*, p. 2678), and the similar nature of the olfactory organ renders it imperative to bring these two within the same sub-family.

In *Tephritis*, again, the ventral fins are closely approximated to one another, and the laminar portions of the pubic bones are well developed and reach almost to the clavicles. The ventral fin of the right or blind side further shows a tendency to become reduced to four rays, and it is therefore permissible for these reasons alone to regard this form as transitional.

The genera which have been included hitherto within the Turbot-group are *Hemirhombus*, *Citharichthys*, and *Citharus*. They are separated from that group, however, by the position of the ventral fins. The asymmetry of these is not so great as in the Turbot-group, and the pubic bones of either side never pass beyond the base of the clavicles. As type of this sub-family we may choose the common Mediterranean form, *Citharus linguatula*. This has invariably been classed with the Turbots, and if the reasons advanced here for its separation from them be considered valid, then the necessity of forming a distinct sub-family for it and the allied genera will be admitted.

In the "*Scandinavian Fishes*" it had already been noted that *Citharus* formed an exception to the general rule in the *Heterosomata bothina* in that it had the rays of the ventral fins close together at the base, whereas in other forms they are wide apart. This external difference has been shown to be associated with a more important internal difference in structure (*vide* Fig. 21), and this has been contrasted with the structure of the ventral fins in *Arnoglossus* (Fig. 23), perhaps the nearest ally to *Citharus* within the Turbot-group. Nor is this the only difference from the latter group to be observed in *Citharus*. Although, according to Günther (20), who had not himself examined any specimens of this species, the dorsal fin extends to the snout anteriorly, it does not in reality do so to the same extent as in the other genera of the Turbot-group, and we find consequently in *Citharus* that there is a different relation between the anterior extremity of the dorsal fin and the nasal organ of the blind side from that in the Turbot-group. In *Citharus* the nasal organ in question lies on the ridge of the snout, just as is the case generally in the Hippoglossinæ and Pleuronectinæ, and as in the latter group the anterior extremity of the dorsal fin inclines towards the blind side on passing the upper eye, so that both nasal organs are on the upper or eyed side of the dorsal fin. This position may be again contrasted with that in *Arnoglossus*, where the nasal organ of the blind side lies on the under side of the dorsal fin.

The genera which are included within this sub-family restricted by the above characters are the following :—

Species Examined.	*Genus.*	*Distribution.*
(?)	Hippoglossina.	Pacific—California to Mexico.
(?)	Licglossina.	California.
(?)	Xystreurys.	South California.
P. maculosus . . .	Paralichthys, Girard.	Both coasts of America to east and south coasts of Asia.
P. russellii . . .	Pseudorhombus, Gtr.	Sub-temperate zones of both northern and southern hemispheres.
(?)	Ramuluria, Jordan and Evermann.	California.
(?)	Ancylopsetta, Gill.	South Atlantic coasts of North America.
(?)	Notosema, Goode and Bean.	Do.
(?)	Gastropsetta, Bean.	Do.
(?)	Trichopsetta, Gill.	Do.
H. aramaca . . .	Hemirhombus, Bl.	Tropical Atlantic coasts of America and Africa, also Pacific.
(?)	Cyclopsetta, Gill.	Colombia and Gulf of Mexico.
(?)	Azevia, Jordan.	Pacific coast of Central America.
C. sordidus . . .	Citharichthys, Blecker.	Tropical and sub-tropical coasts of America.
T. sinensis . . .	Tephritis, Gtr.	China Seas.
P. erumei . . .	Psettodes, Gtr.	Red Sea to China.
C. linguatula . .	Citharus, Bl.	Mediterranean.
(?)	Anticitharus, Gtr.	Australasia.

It has to be admitted that this family rests for the present upon somewhat hazardous generalisations. As noted above, only seven* species of the various genera have been examined, whereas, according to Günther's Catalogue of 1862, twenty-one species are included therein, and if the most recent catalogue of the American writers be taken into account this number is almost doubled. It is therefore advisable to point out in detail the extent of the generalisations. In the case of *Paralichthys* and *Pseudorhombus*, it is assumed that the species which have not been examined have the same form of olfactory organ as those examined. In the case of the remaining genera it is also assumed that the ventral fins are placed posterior to the base of the clavicles. The first assumption is based on the fact that all the examined forms, Soleinæ and others, with a similar distribution, viz.—sub-temperate and tropical —have the same type of olfactory organ, in which the olfactory laminæ are arranged about a median rachis. The second assumption is not so well grounded, and unfortunately the descriptions of previous writers are too indefinite to give much aid. All that one can gather from the descriptions of Günther and the American writers is that what is true for the one species holds good also for the remaining species of the genus. In this case the above characters are true for the sub-family as it stands, but more specimens and species require to be examined in order to settle the matter definitely. Some alterations may require to be made, as, for example, in *Hemirhombus* (*Syacium*), whose ventral fins, according to the American writers, are peculiar, but they may not affect the validity of the sub-family as a whole.

The distribution of the various genera included within this family is more southerly than that of the previous family, being tropical and sub-temperate in both the northern and southern hemispheres.

*Through the kindness of Prof. D'Arcy W. Thompson, three more species of this sub-family, viz.:—*Paralichthys arsius, Paralichthys dentatus,* and *Citarichthys spilopterus,* have been examined since the above pages were written. These conform to the characters stated, and consequently, enhance the validity of the sub-family.

Sub-fam. *Rhombinæ* *

(1) As in Hippoglossinæ.
(2) As in Hippoglosso-rhombinæ.
(3) Ventral fins asymmetrical, the anterior extends anteriorly beyond the base of the clavicles; the laminar portion of one or both of the pubic bones is continued forward by a plate of cartilage as far as the lower prong of the urohyal.
(4) Nasal organ of the blind side lies entirely on the blind side of the head under the anterior extremity of the dorsal fin.
(5) As in Hippoglossinæ.†
(6) Eyes on left side.

The following genera are now included in this family :—

Species Examined.	*Genus.*	*Distribution.*
R. mancus . . .	Rhomboidichthys, Bl. (Platophrys, Swainson).	Sub-tropical regions of Atlantic and Pacific.
(?)	Perissias, Jordan and Evermann.	Gulf of California.
(?)	Eugyophrys, Jordan and Bollman.	Coast of Panama.
A. grohmanni . .		
A. laterna . . .	Arnoglossus, Ron. (Platophrys, Swainson).	Sub-tropical regions of Pacific and Atlantic.
L. boscii . . }	Lepidorhombus, Gtr.	Temperate seas of Europe.
L. whiff . . }		
S. unimaculatus . }	Scopthalmus, Bon.	Do.
S. norvegicus . }		
Z. punctatus . . .	Zeugopterus, Gottsche.	Do.
R. lævis . .	Rhombus,* Kl.	Temperate regions of North Atlantic.
R. maximus . .		
B. mæoticus . .		
(?)	Etropus, Jordan and Gilbert.	Sub-temperate regions of America.
P. ocellatus . . (?)	Psammodiscus, Gtr.	(?)
(?)	Monolene, Goode.	Tropical and sub-temperate regions of Atlantic.

* This genus has been variously styled by the above mentioned authors, *Psetta*, *Pleuronectus*, *Bothus*. As the reasons for adopting these are somewhat hazy, there is insufficient ground for departing from the now familiar term *Rhombus*.

Under previous classifications this sub-family was more clearly separated from the other families of the Heterosomata than it is under the present. And if the Turbot (*R. maximus*), which was formerly the type of the family, were contrasted directly with the Pleuronectinæ and the Hippoglossinæ, we should be inclined to think that the Heterosomata had had two distinct sources of origin. It has been shown here, however, that *Citharus* and its allied genera form a natural transition from the Hippoglossinæ to the Rhombinæ, and that the latter family has first made its appearance in some form akin to *Arnoglossus*, if not in *Arnoglossus* itself. It is most probable, indeed, that the Rhombinæ had their origin in the sub-temperate or tropical zones, and thence migrated northwards. The Turbot, Whiff, and Topknots are specialisations along certain lines away from the main body of the Heterosomata.

* This sub-family has been variously called *Rhombinæ*, Gill; *Pleuronectinæ*, Jordan and Goss; *Bothinæ*, Smitt; *Psettinæ*, Jordan and Evermann, Gill. Each of these is well supported by weighty reasons, and one has therefore a considerable latitude of choice. In deciding upon *Rhombinæ* for the sub-family as above restricted, I have taken into consideration not only questions of priority, but also the fact that *Rhombus* is now the customary and recognised term for the type of this sub-family, amongst European ichthyologists at least.

† According to Jordan and Evermann (33, p. 2687), *Etropus* is an exception, having a small mouth, as in the *Pleuronectidæ*.

Fam., *Soleidæ*.

(1) " Preopercular margin aduate, hidden by the skin and scales of the head."
(2) Olfactory laminæ arranged about a rachis, which may lie obliquely or even transversely to the longitudinal axis of the body.
(3) Ventral fins symmetrical or asymmetrical; two, one, or absent altogether.
(4) Nasal organ of blind side similarly situated to that of eyed side.
(5) Mouth a symmetrical; dentition (if present) more developed on blind than on eyed side; mouth usually overhung by a definite snout.
(6) Eyes on right or left side.

It has been thought advisable to retain the latest classification of the American writers, and consider the Soleidæ as a family equivalent to the preceding sub-families combined. This has the advantage of dividing the Heterosomata into two main portions with an almost equal number of species in each, and it has the further advantage of a suitable terminology. But it has the great disadvantage of obscuring somewhat the natural affinities of the various groups. For this purpose it would be better if the family Soleidæ were done away with, and a classification similar to that proposed earlier by the American writers (32) established. In the latter, the Heterosomata were arranged in a series of sub-families, two of which—Soleinæ and Cynoglossinæ—represented the present family. It was then possible to arrange the characters of the various groups, so that the Cynoglossinæ were related to the Soleinæ as the Soleinæ were to the Pleuronectinæ and Rhombinæ, and the last two to the Hippoglossinæ. In the more recent classification (33) the Soleidæ are divided into three sub-families, Achirinæ—the American Soles, Soleinæ—the European Soles, and the Cynoglossinæ. Few of the American Soles have been examined by myself, so that the characters (2) and (4) above may not be altogether true for them, although they hold good for both the Soleinæ and Cynoglossinæ.

According to the American writers, the American Soles are allied to the Turbot-group (Rhombinæ) in the form of their ventral fins, whilst, as has been shown here, the European soles are more nearly allied to the Plaice-group. On the other hand, the Cynoglossinæ form an aberrant group whose affinities are by no means clear. They have been derived apparently from the Soleinæ or Achirinæ, but the transitional stages are not yet in evidence. It is to be understood, therefore, that the affinities of the various groups of Heterosomata are displayed by the sub-families, whilst the families are for convenience in classification.

The characters of the sub-families of the Soleidæ are as follows, those stated by the American writers being given in brackets:—

1. *Achirinæ*.

(Eyes on right side; ventral fins developed, one or both of them sometimes obsolete; right ventral with extended base, confluent with the anal fin.)

Species Examined.	*Genera.*	*Distribution.*
	Achirus, Lac.	Tropical and temperate regions of America.
G. fasciatus, . . .	Gymnachirus, Kaup.	Tropical South America (?)
S. unicolor, . . .	Soleotalpa Gtr. (Apionichthys, Kaup.).	Tropical regions of Atlantic.

2. *Soleinæ.*

Eyes on right side; ventral fins developed and free from anal.

Species Examined.	*Genera.*	*Distribution.*
S. vulgaris,	Solea, Quen.	Sub-tropical and temperate regions of Europe.
S. lascaris, — *kleinii,* — *impar,*		
S. ocellata,	Microchirus, Bon.	Mediterranean and temperate regions of Europe.
M. variegata,		
M. minuta,		
M. hispidus,	Monochirus, Raf.	Mediterranean.
S. pectoralis,	Synaptura, Cantor.	Indian Ocean and Archipelago.
P. pavoninus,	Pardachirus, Gtr.	Do. do.
A. cornuta,	Aesopia, Gtr.	Do. do.
L. nitidus,	Liachirus, Gtr.	China Seas.

3. *Cynoglossinæ.*

Eyes on left side; only one ventral (?); dorsal and anal fins confluent with caudal; termination of caudal vertebræ of axial type—diphycercal.

Species Examined.	*Genera.*	*Distribution.*
C. semilævis,	Cynoglossus, Gtr.	China Seas.
P. marmorata,	Plagusia, Gtr.	East Indies.
A. lacteus,	Ammopleurops, Gtr.	Mediterranean.
A. ornata,	Aphoristia, Kaup.	Atlantic coasts of tropical America.

It may be possible to find further structural characters which differentiate these sub-families from one another, more especially the Achirinæ from the Soleinæ. The Cynoglossinæ are more specialised than either of these, and, in addition to their sinistral form, present stages of specialisation which can be well marked off from the transitional forms of the above sub-families. The confluent nature of the vertical fins occurs but seldom in these sub-families—*e.g.*, in *Soleotalpa* and *Synaptura*. In these, however, the termination of the notochord is slightly bent upwards (*Soleotalpa ?*) as in *Solea*, so that the axial arrangement of the caudal vertebræ, which marks the last degree of specialisation, is distinctive of the Cynoglossinæ. The other characters, the total absence of the pectorals, and the presence of only one ventral, are found also in the other sub-families—*e.g.*, in *Soleotalpa*, *Gymnachirus*, and certain species of *Synaptura*. Between the Soleinæ and the Achirinæ there seems at present only the one differentiating character, and it is of interest to note that it is the same character which forms the chief means of differentiating the Pleuronectinæ and the Rhombinæ, although it has yet to be seen whether the same difference in the internal structure of the pectoral arch and ventral fins is present.

The more specialised forms are found in the tropics, whilst the less specialised range into the temperate regions of the northern hemisphere.

Sub-fam. *Solei-pleuronectinæ.*

(1) and (2) As in *Pleuronectinæ.*
(3) Ventral fins asymmetrical; two or one.
(4) As in *Pleuronectinæ?*
(5) Mouth asymmetrical, as in *Pleuronectinæ.*
(6) Eyes on right side.

This sub-family has already received the name Oncopterinæ from Jordan (32, p. 280), and it might seem as if an unnecessary reduplication of terms was being made. As a matter of priority, however, *Rhombosolea* was the term given by Günther to the genus (21, p. 557), and instead of the name of the last discovered species, *Oncopterus*, being given to the sub-family, Rhombosoleinæ should rather have been employed. The latter term also would have had the additional advantage of declaring certain affinities of the group, whereas Oncopterinæ is an empty term. The doubt, therefore, lay between Solei-pleuronectinæ and Rhombosoleinæ, and it is considered that the weight of the characters decides in favour of the former. The asymmetrical condition of the ventral fins resembles the same character in the Turbot-group certainly, but, as remarked by Jordan, this is also the characteristic of the Achirinæ of the Sole-group. This sub-family, again, has the same disposition of abdominal vertebræ—*i.e.*, the last four to six bear hæmapophyses—as is found in certain of the Turbot-group—*e.g.*, *Rhombidichthys*; but this has also been shown to be a general characteristic of the Soles. Hence, there is reason for considering that these characters have come from the Soleidæ and not the Bothinæ. This is further shown in the shape of the snout and mouth, which are almost half-way between the types of the Sole- and Plaice-groups. In the remainder of its characters, with the possible exception of the position of the nasal organ of the blind side, which has not yet been determined, this sub-family distinctly resembles the Plaice-group. The eyes are on the right side, and the olfactory organ is the same as in the Pleuronectinæ and Hippoglossinæ.

The genera included under this sub-family are, for the present, three —viz., *Rhombosolea*, *Peltorhamphus*, and *Ammotretis*, all from the waters south of Australia, from Tasmania and New Zealand. These are so distinct in their characters that—as characters are measured amongst the European species—each is entitled to represent a separate genus. As already mentioned, Jordan has classed with these a form from the Patagonian coast of South America, namely *Oncopterus*. This has certain remarkable resemblances to the above, but differs from them in that the ventral fin is not joined to the anal, where in the above it is. The interesting point to determine now is whether *Oncopterus* has the same type of olfactory organ as the others, and a similar disposition of the abdominal vertebræ. If so, then it is very probable that a number of forms intermediate in their geographical distribution between the above may still be found which will fall within this sub-family.

Incertæ Sedis.

Whilst it has been possible to give a certain amount of definiteness to the preceding sub-families, there still remain a few forms—some of which do not fall within the previous groups, and others not examined by myself —which have been given a separate and special importance by the American writers. As it is impossible to say exactly where the latter would fall in the present scheme of classification, it is better to consider them apart until further examination of their structure reveals their affinities.

One of these remarkable forms is *Brachypleura*, which includes several species from the Indo-Pacific Ocean and from New Zealand. This was placed by Günther (20, p. 556) in the Turbot-group, on account of its having a "nearly symmetrical mouth" and because "the dorsal fin commences before the eye." A further character may be added to complete its resemblance to the Turbots, namely that the ventral fins are unsymmetrical. But here the resemblance ceases, and *Brachypleura* has even less affinity to the Turbot-group than the Solei-pleuronectinæ had. The ventral fins though unsymmetrical are only slightly so, and are similar in structure and position to those of the Hippoglosso-bothinæ. Further, as in *Citharus*, *Platophrys*, and the Soleidæ, some of the abdominal vertebræ bear hæmapophyses. As with the Solei-pleuronectinæ, these last two characters are considered to show affinities with the Soleidæ. On the other hand, the structure of the mouth is hippoglossoid, the eyes are on the right side, and the olfactory organ, though little developed apparently, is of the same type as in the Plaice- and Halibut-groups.

Brachypleura has therefore very close affinities to the preceding sub-family, Solei-pleuronectinæ, and differs from it chiefly in the form of the mouth. In order to mark this affinity, and at the same time display the difference, it might be advisable—in the event of further related species coming to hand—to raise this genus to the rank of a sub-family and call it Solei-Hippoglossinæ.

Another genus whose position is uncertain is *Samaris*. This resembles *Brachypleura* in many of its characters, but in its general form as well as the position of the ventral fins shows a greater resemblance to the Turbot-group. The eyes are, however, on the right side. The structure of the olfactory organ is not yet known. Jordan (32, p. 229) has included with this several other genera, *Lophonectes*, *Pœcilopsetta*, *Nematops*, and formed them into a distinct sub-family which he calls Samarinæ. Future research may show, however, that the two latter should be grouped with the Solei-pleuronectinæ. According to Jordan this sub-family lies between the Plaice and Turbot-groups, but one result of the present investigation is to show that these two groups have been and are in no way related to one another. They are both specialisations from the main stock in different directions, and an intermediate group is unlikely—unless it arose through hybridism. The above genera may be transitional stages from the Halibut-or Turbot-groups to the Sole-group or *vice versâ*, or they may be highly specialised members of the Plaice-group.

Another genus of uncertain position is the *Lepidopsetta* of Günther (22), (*Mancopsetta* of Jordan). This comes from the southern end of South America, and seems to display affinities both to the Soles and Turbots.*

* Through the kindness of Prof. D'Arcy W. Thompson, C.B., of the University College, Dundee, and of his assistant, Dr. W. T. Calman, I have been able to examine some additional forms, and had access to additional literature, since the above pages were written. From these observations it seems very probable that the Deep Sea forms of the Indian Ocean described by Alcock (1, 2, 3), connect the flat-fish fauna of the temperate regions of the northern hemisphere with that of the similar regions in the southern hemisphere. Of these forms *Boopsetta* (*Pœcilopsetta*) seems to be one of the Plaice-group, whilst *Lœops* is of the Turbot-group. In the deep sea forms, therefore (*Chascanopsetta* is another), we may perhaps have the transitions from the Plaice- and Turbot-groups of the northern hemisphere to the Solei-pleuronectinæ of the southern. It would be of interest to know whether the forms mentioned had the Plaice or Turbot type of olfactory organ. In this connection, it may be mentioned that a specimen found at University College, which came from New Zealand and seems to be the representative of a hitherto undescribed species, has the external appearance and character of the Turbot group, but the Plaice type of olfactory organ.

Geographical Distribution of the Sub-Families.

It has at times been asked whether the flat-fishes could not be considered as having sprung from more than one stock, that is, as having two or more distinct sources of origin. The doubt concerning this point is centred round the great differences between the Turbot-group and the Plaice-or Halibut-groups. The Sole-group—in the European fauna at any rate—is readily recognised to have close affinities with the Plaice-group, whereas no other groups are so widely separated from one another as the latter and the Turbot-group. Nor are these differences—which have been displayed in the earlier portions of this paper—confined to the adult structures, they are also found in the earliest stages. The eggs of all the species of the Plaice-and Halibut-groups yet known are transparent and without oil-globules like those of the Gadidæ, whereas all the species of the Turbot-group have, without exception up to the present time, an oil-globule which may be coloured or colourless. The larvæ and post-larvæ of the latter group, again, are readily distinguished from those of the former by the very early anterior prolongation of the dorsal fin over the migrating eye, and by the presence, in several species, of spines on some part of the head, in other species of tentacular prolongations of the anterior rays of the dorsal fin.

These great differences throughout might lend countenance, therefore, to the possibility of there being two separate origins for the flat-fishes. But such an hypothesis could only obtain a firm ground in fact if it were shown that no transitional stages existed between the Turbot and Halibut-or Plaice-groups, and is at once disposed of if such transitional stages are found. In the preceding pages it has been shown that the *Citharus*-group intervenes between the Halibut-and Turbot-groups, and that the transitional forms are all present in the existing fauna. It becomes necessary, then, to take a broad survey of the various characters in order to display their gradual transition from the one group to the other, and this can be most readily accomplished by following the geographical distribution of the various sub-families.

Beginning in the northern parts of the northern hemisphere, and restricting attention mostly to the European forms, we find that the Hippoglossinæ are the sole representatives of the flat-fishes in the extreme north. It is there that we find the nearest approximation to the round-fishes in species which have the eye of the blind side on the ridge of the head. Closely allied to these we find other species, *e.g.* the Halibut, which have a broader or deeper body, and both eyes on one side of the head. The chief characters of these, according to the foregoing classification, are the large and nearly symmetrical mouth, the symmetrically-placed ventral fins, the eyes on the right side of the head, and the lamellar type of olfactory organ. As we approach nearer to the coasts of northern Europe we find another form making its appearance, which only differs essentially from the above in the shape of its mouth. This second form—the Plaice-group—differs from the former in having a smaller mouth, which is twisted towards the under side. A further difference, slight in itself but of some significance, is the more anterior position of the anterior extremity of the dorsal fin.

The Halibut and Plaice-groups are found together in the northern portions of the temperate region, the latter extending further south than the former, but as we proceed towards the warmer regions of the temperate zone both groups decrease in number to the vanishing point, and we find their places taken by forms which have undergone some remarkable changes. The asymmetry of the flat-fish, which in the above groups was restricted to the bones round the eyes and mouth, now

passes backwards to the body, and both the pectoral and ventral fins begin to degenerate. Those of the eyeless side grow smaller than those of the eyed side, and in the end do not develop at all. As might be imagined from their relative positions, the ventral fins display the various stages in specialisation much better than the pectorals do, although we can trace the specialisation along both lines in separate groups. Following firstly the fate of the ventrals, we find that the ventral fin of the eyed side pushes forward in front of its fellow until it reaches and is joined on to the base of the clavicles. This forms a well-marked stage limiting off the *Citharus* from the Turbot-group, and is accompanied by other characters which display its differentiation from the Halibut-group. Not only is the asymmetry of the *Hippoglossus*-type increased, but the type itself seems to be wavering in the balance. In the Halibut-group the eyes are almost invariably on the right side,* in the species of the *Citharus*-group the eyes may be either on the left or right side, but most frequently on the left.† This peculiar phenomenon seems to be connected with some changing element in the environment. In the Flounder *(P. flesus)*, for example, whose young migrate at an early stage from salt to fresh water, and in which the eyes are normally on the right side as in the other species of the Plaice-group, we find that from six to ten per cent. of the individuals on certain grounds may have their eyes on the left side. Why this change should occur in some individuals and species and not in others is still a mystery, but meanwhile we may note that it is a characteristic of the Hippoglossobothinæ.

Another great change from the Halibut type, whose meaning and importance are not yet clear, occurs in the olfactory organ. It is somewhat difficult to imagine any transitional stage between the lamellar form of olfactory epithelium and the rosette-shape form, but we may possibly yet find that both forms occur within the bounds of one of the transitional genera, *e.g. Paralichthys*, which is the most nearly allied to the Halibut-group. On the other hand, one might think that the rosette-shaped form was of greater physiological importance than the other, and we can thus understand its universal prevalence amongst the forms of the sub-temperate and tropical seas, where the eyes have degenerated and the sense of smell is the chief means of detecting food. These are problems for the future, however; at present it is only possible to point out their significance.

The *Citharus*-group appears to have sprung directly from the Hippoglossinæ. In the European fauna we have only one representative of the group, namely *Citharus* (*Hippoglossus* of Cuvier, 11), but in the American fauna the transitional stages are more in evidence, from *Paralichthys* with the ventral fins as in the Halibut-group, through *Pseudorhombus*, in which the ventrals are close to the base of the clavicles, to *Hemirhombus* and *Citharichthys*, in which the ventral fins have become slightly asymmetrical, but are still behind the clavicles as in *Citharus*. With regard to distribution, also, the American forms range further to the north than *Citharus*, overlapping the hippoglossoid-forms. As a sub-family this group has the widest range of any. Its altered hippoglossoid characters make it well adapted to the warm seas, and it ranges all round the globe within the tropical and sub-temperate zones of the southern apparently as well as of the northern hemisphere.

* Jordan (33, p. 2615) cites *Hippoglossoides elassodon* as being sometimes sinistral.

† The only writer, to my knowledge, who has examined any specimens of *Citharus* itself with the eyes on the right side, is Linneus (35, p. 1233). There he describes his genus *Linguatula*, which apparently applies to *C. linguatula*, as now known, as *Pleuronectes oculis a destra*.

Thus far we have traced one of the main lines of descent from the Halibut-group from the Arctic Seas to the tropics. There is still another main line, but before proceeding to its discussion it is necessary to refer to a sub-branch or offshoot which has sprung from the Hippoglosso-bothinæ. This, the Turbot-group, has the essential characteristics of the former, and has varied from it through the eyes becoming definitely fixed on the left side, and through the ventral fin of the eyed side, or both fins, developing forwards anterior to the base of the clavicles. This group belongs almost exclusively to the northern hemisphere, the various genera having migrated northwards from the sub-temperate and tropical regions—the original home of the group. The northern forms, the Turbot, Whiff, and Topknots, show that they have become specialised, so that if we wish to retrace their affinities we must return through the Brill to *Arnoglossus*, and thence to *Citharus*. It is of interest to note also that whilst the Hippoglosso-bothinæ have remained predominant in the American fauna, and the Turbot-group is barely represented there, the reverse is the case in the European fauna. The Hippoglosso-bothinæ are represented by only one form, and the Turbot group is predominant.

The second main line of descent from the Halibut-group passes downward through the Plaice-group to the Soles. This at least is one of the sources from which the Soles have sprung, and it is represented mostly by the European Soleinæ. In these the ventral fins are symmetrical, and the eyes are on the right side as in the Pleuronectinæ. The specialisation within this sub-family displays itself in the gradual decrease in size of the pectoral fins (*Microchirus*), and the disappearance of the pectoral of the left or eyeless side (*Monochirus*). Accompanying these external changes is an internal change in the structure of the abdominal vertebræ, which is found also in the transitional forms of the Hippoglosso-rhombinæ and Rhombinæ. The posterior abdominal vertebræ bear hæmapophyses, and the first interhæmal spine decreases greatly in size. In these respects, therefore, as well as in the form of the olfactory organ, the Soleinæ display affinities to the *Citharus* and Turbot-groups, whilst in the structure of the mouth, position of the eyes, and symmetry of the ventral fins they are more nearly related to the Plaice-group. It is thus impossible to draw a hard and fast line between the separate groups, although the probability is in favour of this group of Soles having sprung from the Plaice-group. The similarity of the olfactory organ and of the abdominal vertebræ in *Citharus*, *Platophrys*, and the Soleinæ is the sign of a certain amount of similarity in the habits and surroundings of these genera, whilst the other characters seem to be the persistent inheritance from the more northern Plaice-group. If this were not the case, we should expect that these characters—the position of the eyes and of the ventrals—would also have changed. The forms which are allied to the plaice group are distributed chiefly in the tropical and sub-temperate zones, in the Indian Ocean (*Synaptura*), and Mediterranean, but a few species range as far north as the Scandinavian coasts (*Solea vulgaris*).

On the other hand, the American Soles seem to have sprung from the Hippoglosso-rhombinæ. The ventral fins are here asymmetrical, and the eyes are on the left side. They do not seem to range to the northward as the European Soles do, but towards the south into the tropical regions. As in the latter sub-family, the pectorals in the Achirinæ (American Soles) gradually degenerate until they finally disappear.

The specialisation of structures which is found in the Soleinæ and Achirinæ reaches the culminating point in the Cynoglossinæ. The pectorals and one ventral disappear, the eyes have become very small,

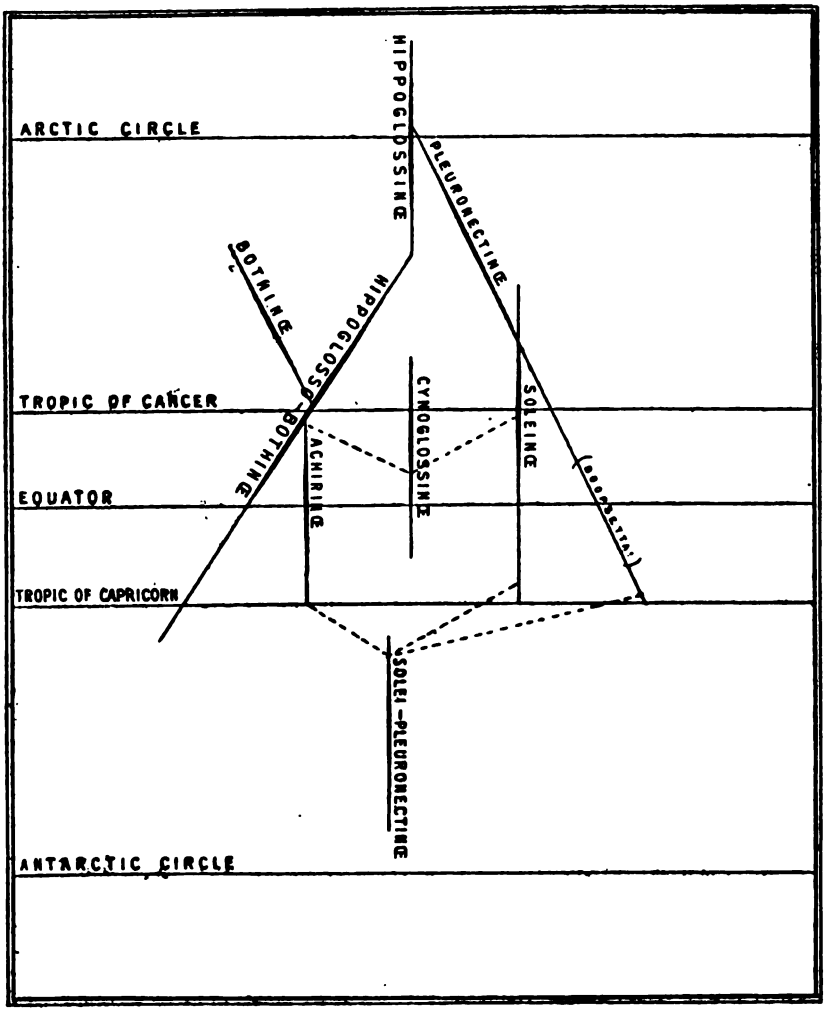
and the termination of the vertebral column, continuing what had only begun in the previous sub-families, has assumed an axial form and become diphycercal. The distribution of this sub-family is similar to that of the tropical forms of the two preceding sub-families, and it is difficult to say from which of these two the Cynoglossinæ have been derived, probably from both.

Thus far it has been possible to pass over in review the various groups of the flat-fishes which are found between the Arctic Seas and the tropics. It has been assumed that their primitive home was in the former regions, and that the various changes in structure which present themselves as we pass from the one end to the other are specialisations or adaptations to special habits and habitats. Since the series from the least to the most specialised is fairly well complete, we might think that all the forms that could occur must lie somewhere within the groups which have already been described. In reality, however, we may have little more than half of the story, and the few forms yet known from the temperate regions of the southern hemisphere make this very probable. Passing over the aberrant *Lepidopsetta* (*Mancopsetta*) of South America, which is at present an isolated "fact," we have the Solei-Pleuronectinæ of the southern Australasian fauna, which display some remarkable transitional characters. They have been recognised by Jordan, even from the external characters, as having certain resemblances to the Pleuronectinæ, and this resemblance is still further increased by the fact that they have the same type of olfactory organ. In other characters—structure of the ventral fins and of the abdominal vertebræ—they resemble *Platophrys* of the Turbot-group and the *Achirinæ* amongst the Soles.

One may readily understand how the asymmetry of their ventral fins may have arisen, on the principle aforementioned that this asymmetry is chiefly a persistent inheritance from a tropical ancestor, but their having the type of olfactory organ which is found only in the temperate and Arctic regions of the northern hemisphere is harder to explain. There seem to be but two possibilities—either that some of the species which have made their way from the northern hemisphere through the tropics have retained this form of olfactory organ throughout, or that the olfactory organ has again changed in the temperate regions of the southern hemisphere from the rosette-shaped to the lamellar form, just as it changed in the reverse direction in the northern hemisphere.* Sufficient knowledge has not yet been gained to enable one to say definitely which of these possibilities is the correct one. On the former we should expect to find intermediate forms which have the lamellar form of olfactory organ, in the regions between Australia and the China Sea. If these are not to be found, we should be inclined to believe that these forms show a specialisation away from the Sole-type; *i.e.*, in an environment similar to that of the temperate regions of the northern hemisphere, that the Sole type is gradually changing to the Pleuronectid. In such a case—and *Brachypleura* of the same regions is another example of the same process—we are led to think of Murray's hypothesis of the bipolar origin of the oceanic fauna (41), and its more recent discussion by Herdman (24) and Thompson (53). If it is possible for the structures of the flat-fishes so to alter as they pass from the tropics to the Antarctic circle that they reassume in many ways a similar appearance and similar structures to those in similar regions of the northern hemisphere, then it is not difficult to see how a false appearance of identity may arise between the forms of the Arctic and Antarctic seas.

* See footnote p. 361

The subjoined sketch represents the distribution and the affinities of the various sub-families of the *Heterosomata*, the darker portions of the lines showing where each is most abundant, and the dotted lines show the doubtful affinities.



BIBLIOGRAPHY.

1. Alcock A.—Illustrations of the Zoology of the Royal Indian Marine Survey Ship *Investiyator*, 1898.
2. Alcock, A.—"A Guide to the Zoological Collections exhibited in the Fish Gallery of the Indian Museum," 1899.
3. Alcock, A.—"A Descriptive Catalogue of the Indian Deep-Sea Fishes in the Indian Museum," 1899.
4. Agassiz, A.—"On the Young Stages of Osseous Fishes," *Proc. Amer. Acad. Arts and Science*, 1877.
5. Agassiz, A.—"Development of the Flounders," *ibid.*, 1878.
6. Bateson, W.—"Sense-Organs and Perceptions of Fishes," *J.M.B.A.*, v. I., n.s., 1889-90.
7. Cole, F. J.—"Observations on the Structure and Morphology of the Cranial Nerves and Lateral Sense-Organs of Fishes; with special reference to the genus *Gadus*," *Jour. Linn. Soc.*, 1898.

8. Costa, O. G.—"Fauna del Regno di Napoli," Naples, 1850.
9. Cunningham, J. T.—"A Treatise on the Common Sole," 1890.
10. Do. —"Diagnostic Characters in Flat Fishes," *J.M.B.A.*, v. III., 1893-95.
11. Cuvier, G.—"Le Règne Animal," 1817.
12. Do. —"L'Histoire Naturelle," 1828.
13. Day, F.—"British Fishes," 1884.
14. Do. —"On a Supposed Hybrid between the Dab (*P. limanda, L.*) and the Flounder (*P. flesus, L.*)," *Proc. Roy. Soc.*, 1885.
15. Dean, Bashford—"Fishes, Living and Fossil," 1895.
16. Duncker, G.—"Der Elbbutt, eine Varietät der Flunder," *Schr. d. Natura-Ver. f. Schleswig-Holstein*, B. IX., 1892.
17. Duncker, G.—"Ein muthmalslicher Bastard zwischen, *P. platessa L. und P. Limanda L.*," *Zool. Anz.*, 15 Jhrg., N. 407, p. 451-453.
18. Edwards, H. Milne—"Leçons sur la Physiologie et l'Anatomie Comparée," vols. II. et IX., Paris, 1874.
19. Ehrenbaum, E.—"Eier u. Larven v. Fischen d. Deutschen Bucht," *Wissen. Meeresunter.*, 1896.
20. Günther, A.—"Catalogue of Fishes in the British Museum," v. IV., 1862.
21. Do. —"The Study of Fishes," 1880.
22. Do. —"The Voyage of H.M.S. *Challenger*: Report on the Shore Fishes," Zoology, v. I., 1880.
23. Günther, A.—*Ibid.*, "Report on the Deep-Sea Fishes," v. XXII., 1887.
24. Herdman, W. A.—Presidential Address to the Zoological Section of the British Association, Ipswich, 1895.
25. Holt, E. W. L.—"Studies in Teleostean Morphology," *Proc. Zool. Soc.*, 1894.
26. Holt, E. W. L.—"Recherches sur la Reproduction des Poissons Osseux," *Ann. du Musée d'Hist. Nat. de Marseille*, Mem. 2, 1899.
27. Howes, G. B.—"On the Intestinal Canal of the Ichthyopsida," *Jour. Linn. Soc.*, v. XXIII., 1890.
28. Huxley, T. H.—"On the Development of some Parts of the Skeleton of Fishes," *A.J.M.S.*, 1859.
29. Huxley, T. H.—"Ceratodus Forsteri, with Observations on the Classification of Fishes," *Proc. Zool. Soc.*, 1876.
30. Huxley, T. H.—"Anatomy of Vertebrate Animals," 1880.
31. Jordan, D. S., and Gilbert, C. H.—"Synopsis of the Fishes of North America," *Bull. U.S. Nat. Mus.*, 1883.
32. Jordan, D. S., and Goss, D. K.—"A Review of the Flounders and Soles (*Pleuronectidæ*)," *U.S. Comm. of Fish and Fisheries*, 1886 (1889).
33. Jordan, D. S., and Evermann, B. W.—"The Fishes of North and Middle America," Washington, 1898 (1899).
34. Kyle, H. M.—"On the Existence of Nasal Secretory Sacs and a Naso-pharyngeal Communication in Teleostei," *Jour. Linn. Soc.*, 1900.
35. Linneus, C.—"Systema Naturæ," T. I., p. 3.
36. Masterman, A. T.—"Skeleton of the Tunny," *Scot. Fish. Board Rep.*, v. XII., 1893.
37. Matthews, J. D.—"On the Structure of the Herring and other Clupeoids," *S.F.B. Rep.*, v. V., 1886.
38. M'Intosh, W. C., and Prince, E. E.—"On the Development and Life-Histories of the Teleostean Food and other Fishes," *Tr. R.S.E.*, v. XXXV., 1890.
39. Möbius, K., u. Heincke, F.—"Die Fische der Ostsee," Berlin, 1883.
40. Moreau, E.—"Poissons de la France," 1881.
41. Murray, G.—"The Voyage of H.M.S. *Challenger*: Summary of Results," v. II., p. 1459.
42. Owen, R.—"Comparative Anatomy and Physiology of Vertebrates," 1866.
43. Parker, W. K.—"Shoulder-Girdle and the Sternum in the Vertebrata," Ray Society, 1867.
44. Petersen, C. G. J.—"On the Biology of our Flat Fishes," *Rep. Dan. Biol. Station*, v. IV., 1893.

45. Raffaele, F.—"Le Uova Gall. e le Larve d. Teleostei nel Golfo di Napoli," *Mitt. a. d. Zool.-Stat. zu-Neapel*, VIII., 1888.

46. Ryder, J. A.—"On the Origin of Heterocercy and the Evolution of the Fins and Fin-rays of Fishes," *U.S. Comm. Fish and Fisheries*, 1884.

47. Sauvage, E.—"Mémoire sur la Faune Ichthyologique de la Période Tertiaire," *Comptes Rendus*, Paris, 1872.

48. Sagemehl, M.—"Beiträge zur vergleichenden Anatomie der Fische," I.-II. *Morph. Jahrbuch*, B. IX., 1884.

49. Sagemehl, M.—"Beiträge zur vergleichenden Anatomie der Fische," III., *ibid.*, B. X., 1885.

50. Smitt, F. A.—"Scandinavian Fishes," 1892.

51. Stannius, H.—"Anatomie der Wirbelthiere," Berlin, 1854.

52. Steenstrup, J.—"Fortsatte Bidrag—Oiestillingen hos Flyndrene," Copenhagen, 1878.

53. Thompson, D. W.—"On a Supposed Resemblance between the Marine Faunas of the Arctic and Antarctic Regions," *Proc. Roy. Soc. E.*, 1898.

54. Traquair, R. H.—"On the Asymmetry of the Pleuronectidæ," *Tr. Linn. Soc.*, 1865.

55. Wiedersheim, R.—"Grundriss der vergleichenden Anatomie der Wirbelthiere," Jena, 1898.

56. Williamson, H. C.—"Anatomy of the Pectoral Arch of the Grey Gurnard (*T. gurnardus*)," *S.F.B. Rep.*, XII., 1893.

DESCRIPTION OF PLATES (XI.-XII.)

Fig. 1. *Pleuronectes platessa;* viewed from in front, to show relative positions of dorsal fin (D.) and nasal organs (l.n.o. and r.n.o.).

Fig. 2. *Hippoglossus vulgaris:* do.

Fig. 3. *Rhombus maximus:* do.

Fig. 4. *Solea kleinii;* do.

Fig. 5. *Hippoglossus vulgaris;* to show olfactory organ (o.o.) of right (or eyed) side and nasal sacs (r.n.s. and l.n.s.). The laminæ of the sensory epithelium are arranged longitudinally to the main axis of the body.

Fig. 6. *Rhombus maximus:* olfactory organ of left (or eyed) side. The laminæ are arranged transversely to the main axis about a longitudinal rachis.

Fig. 7. *Solea lascaris;* olfactory organ of left (or blind) side. The olfactory laminæ are arranged longitudinally, the median rachis transversely, to the main axis.

Fig. 8. *Rhombus maximus:* abdominal and five of the caudal vertebræ, showing the unclosed nature of the ribs (p.r.) and parapophyses (p.p.), the transverse processes of the caudal vertebræ (t.p.) continuing into the "pleura-pophyses" (p.p.) of the abdominal vertebræ, and the first interhæmal spine curved forward at its extremity and continued by two small portions of cartilage, so that the abdominal cavity is almost completely enclosed.

Fig. 9. *Solea vulgaris;* abdominal and four of the caudal vertebræ. The hæmal arches are closed (h.p.), the transverse processes of the caudal vertebræ are continued by true transverse processes on the abdominal vertebræ. There is no single first interhæmal spine, but a group of four. These, and not the "hæmapophyses," mark the commencement of the caudal vertebræ.

Fig. 10. *Solea vulgaris;* third last abdominal vertebra. The hæmal arches are completely fused to form hæmapophyses.

Fig. 11. *Rhombus maximus;* third-last abdominal vertebra. The hæmal arches and ribs are free.

Fig. 12. *Rhomboidichthys mancus:* third-last abdominal vertebra. Hæmal arches as in *S. vulgaris*.

Fig. 13. *Citharus linguatula;* termination of vertebral column.

Fig. 14. *Solea vulgaris;* do.

Fig. 15. *Ibid.;* from post-larval specimen; do.

Fig. 16. *Rhombus maximus;* do.

Fig. 17. *Ammopleurops lacteus;* do.

Fig. 18. *Pleuronectes platessa ;* pectoral arch of right or eyed side from its inner aspect, showing the ventral fins (V.) lying posterior to the base of the clavicles (cl.).

Fig. 19. *Rhombus maximus ;* pectoral arch of left or eyed side from its inner aspect, showing the cartilaginous anterior extension (c.V.) of the laminar portion (l.p.) of the pubic bone (p.), the urohyal (u.) to which it extends, and the consequently prolonged anterior position of the ventral fins (V.) relative to the base of the clavicles (cl.).

Fig. 20. *Scophthalmus norvegicus ;* pectoral arch of right or blind side from its inner aspect, showing a further specialisation of condition found in *B. maximus ;* the pubic bone (p.) has its origin from the base of the clavicle (cl.), and the ventral fins (V.) are directly under the anterior extension of the urohyal (u.).

Fig. 21. *Citharus linguatula ;* pectoral arch of the right or blind side from its outer aspect, showing the adnate position of the pubic bone (p.) and ventral fin (V.l.) of the left or eyed side to the clavicles (cl.); both pubic bones and ventral fins are posterior to the clavicles, and those of the right or blind side (V.r.) are slightly posterior to those of the left (V.l.).

Fig. 22. *Ibid. ;* pubic bones, viewed slightly from ventral aspect, showing their relative positions and their fusion posteriorly in a spine.

Fig. 23. *Arnoglossus laterna ;* pectoral arch of the left or eyed side from its inner aspect, showing the transition from *Citharus* to *Bothus ;* the left ventral (V.l.) is prolonged in advance of the base of the clavicle (cl.), whilst the right ventral (V.r.) stops short at the base ; the rays of the former are widely separated from one another as in the turbot, those of the latter are close together as in *Citharus.*

Fig. 24. *Solea vulgaris ;* pectoral arch of right side from its inner aspect, showing the short clavicle (cl.) and the posterior position relative to it of the pubic bone (p.) and ventral fin, which is attached by a ligament only to the urohyal (u.).

REFERENCE LETTERS.

A.—anal fin.
$a._1$, $a._2$—articulating facets on *post-temporal.*
c.—continuation of first interhæmal spine.
cl.—clavicle.
co.—coracoid.
c.V.—cartilaginous continuation of l.p.
D.—dorsal fin.
e.—ethmoid.
ep.—epiural.
f.—frontal.
hy., $hy.^1$, $hy.^2$—hypural elements.
h.p.—hæmapophyses.
i.s.—first interhæmal spine.
l.n.o.—left nasal organ.
l.n.s.—left nasal sac.
l.—ligament.
l.p.—laminar portion of pubic bone.
m.—maxilla.
n.—nasal bone.
n.s.—nasal sac.
o.o.—olfactory organ.
pa.—palatine.
p.—pubic bone.
p.c.—post-clavicle.
pm.—premaxilla.
p.l.—left pubic bone.
p.p.—parapophyses.
p.r.—primary ribs.
p.t.—post-temporal.
r.n.o.—right nasal organ.
r.n.s.—right nasal sac.
sc.—scapula.
s.c.—supra-clavicle.
s.p.—spinous process on pubic.
s. terminal pubic spine.
s.r.—secondary ribs.
t.—turbinal.
t.p.—transverse process
u.—urohyal.
ur.—urostyle.
V.—ventral fin.
V.l.—left ventra
V.r.—right ventral.

X.—ADDITIONAL NOTE ON THE SURFACE-CURRENTS OF THE NORTH SEA.

By T. Wemyss Fulton, M.D., F.R.S.E., Scientific Superintendent.

In the Fifteenth Annual Report of the Board I described in detail the experiments devised by me to ascertain the direction and rate of the surface-currents in the North Sea, and the results obtained up to the beginning of 1897. The method adopted was to set adrift a large number of floats (chiefly bottles) at brief intervals over a long period and at various localities, and to collate the results derived from those that were recovered. Up to the time mentioned the number of "drifters" which had been returned to me, out of some 3550 which were made use of, was 502. Since then an additional 132 have been received, making a total of 634, or nearly 18 per cent. of those thrown into the sea. The "drifters" were of two kinds, paraffined wood and sealed bottles; and the statement previously made that the bottles proved far superior to the other kind is borne out by the further experience, since all of the 132 since recovered were bottles. About 30 per cent. of the bottles made use of were recovered.

The places where the 132 referred to were found were as follows:—Scotland 7 (5 at the Shetlands, 1 at the Orkneys, and 1 recovered by a trawl net east of May Island); England 1, on the coast of Northumberland; Germany (west coast of Schleswig) 6; Denmark, west coast, 49; Sweden, west coast, 16; Norway, 53. None were received from Holland, and those from Norway were found on various parts of the coast, from the entrance to Christianiafjord to the North Cape. When the previous results are combined we have the following:—

England.	Holland.	Germany.	Denmark.	Sweden.	Norway.
95	5	4	57	6	46
1	—	6	49	16	53
96	5	10	106	22	99

As may be seen from the Tables appended, the great majority were recovered in 1897; eight were recovered in 1898, and two in November and December 1899; but some of them did not reach me until the beginning of the present year.

Many of the bottles found belong to lots of which others were previously obtained, and the additional information which they furnish may be considered. Five of them were among the number thrown overboard by H.M.S. *Research*, when engaged in survey work in the Faroe-Shetland Channel, in July and August 1896. The one previously recovered from lat. 61° 1′ N., long. 3° 13′ W., was found near Lerwick, Shetland, about 100 miles to the south-east, in December 1896. One of

* The Currents of the North Sea, and their Relation to Fisheries, Part III., p. 334.

the two now recorded from the same station was picked up at Purköen, Nordland, Norway, on 22nd April 1897, and the other at the extreme northern point of Norway, viz., at the North Cape, on 29th May in the same year; the respective intervals being 266 and 312 days. The distance to the North Cape is about 900 geographical miles, and the rate of drift was about 2·9 knots per day. Of the floats thrown in on 4th August 1896, in lat. 61° 18½ N. and long. 4° 21¼ W., one was recovered after a short interval at Shetland; another was obtained on 3rd August 1897, or exactly a year later, at Rödö, in Helgeland, Norway. Of those set adrift in lat. 60° 2′ N., long. 7° 4′ W., on 6th August, 1896 five were recovered, two at Shetland, and, still earlier, three on the coast of Norway. Of the two since obtained, one was got at Veiholmen, Romsdal, Norway, on 4th November 1897 (after an interval of 455 days), and the other on 14th March 1898, at Mousa, Shetland, where it had doubtless been stranded long before.

By the aid of Mr. R. Duthie, Fishery Officer, a number of other bottles were set adrift on the 17th January 1897, from the s.s. *St. Giles*, at distances of 50 and 100 miles S.S.W. of Bressay Light, Shetland. Of the former lot (ten in number) three were recovered on the coast of Norway, in October and November 1897, and February 1898. One of these was found at Ingöen, Finmarken, near the North Cape, after an interval of 297 days; the distance is about 800 miles, and the rate of drift in this instance is about 2·7 knots per 24 hours. Four of the ten set adrift at the second place were also recovered—one, after 240 days, near the Skaw, Denmark; another, after 241 days, near Christiansand, S. Norway; the third, after 310 days, also near Christiansand, and the fourth, on 5th February 1898, still further to the north-east, near Kragerö, S. Norway.

Of those set adrift further south, one has been returned to me after the long interval of five years (1840 days); it was thrown into the sea eight miles off Buchan Ness, Aberdeenshire, on 5th November 1894, and found on Fröya, near Trondhjem, Norway, on the 20th November 1899. It had no doubt been lying there for years, because of other four of the 20 bottles set adrift at the same time which were recovered, three were picked up in December 1894, two near Trondhjem, and one at Brandesund, near Bergen; the fourth was found at the Fro Islands, also near Trondhjem, in December 1895. It is curious that all of them were got in the months of November or December. Another bottle, put away in the Moray Firth on 2nd August 1895, was found on 17th December 1899, after an interval of 1597 days, at Mandal, in the south of Norway. Other two of the same lot (ten in number) were picked up in the same locality in November 1895.

In many cases the results of the experiments illustrate in a marked manner the views expressed in my previous paper, as to the general direction of the surface-currents in the North Sea; and they show the necessity of conducting such observations with a large number of floats. For instance, of twenty bottles set adrift on 22nd July 1896, ten at the Bell Rock Lighthouse, and ten 10½ miles S.E. of Bervie, Kincardineshire, three were recovered on the Norwegian coast; one on 1st April 1897 (after 252 days), sonth of Stavanger, one on 15th May 1897 (after 297 days), near Bergen, and one at Engel Island, Nordland (very much further to the north), on 1st November 1897, after 467 days. These facts taken alone would point to a movement northwards from the region where the bottles were set adrift. But the previous records show that the bottles first of all moved south along the east coast of this country, because others were found on the coast of Fife and East Lothian a few weeks after they had been sent on their journey, and one on the coast of

Northumberland still later. The same result is shown in other cases. Of ten set adrift on the same date, 22nd July 1896, four miles south-east of Buchan Ness, Aberdeenshire, two were picked up at sea a few days later (15 and 24 miles S.E. of Aberdeen), and other three on the coast of Northumberland, 49, 51, and 57 days afterwards. On 5th May 1897 (287 days) one was found near Hantsholm, on the north-west coast of Denmark, and another on 3rd August 1897 (after 377 days) between Mandal and Christiansand on the south coast of Norway. Of ten put adrift on the same date, 8 miles N.N.E. of Scarnose Point, Banffshire, two were picked up on the adjoining coast to the south, a few days later; another was found floating in the sea 65 miles N.E. by E. of Spurn Point, Yorkshire, on 3rd December 1896, after an interval of 134 days; and a third was got near Stromstad, in the north of the west coast of Sweden, on 21st October 1897, after 456 days. In another case where ten bottles were set adrift on 13th October 1896, 5 miles south-east of Girdleness, Aberdeenshire, one was found at Whitby, in Yorkshire, 172 miles to the south, after an interval of 100 days; another was found on 16th May 1897, after 215 days, at Sondervig, on the west coast of Denmark; a third on 11th July 1897, after 271 days, at Römo, Schleswig; a fourth on 6th August 1897, after 297 days, near Varde, on the southern part of the west coast of Denmark; and a fifth on 7th July, after 267 days, on the west coast of Sweden.

Advantage was taken of the ordinary steamer routes from the Firth of Forth to the Continent to set off drifters at various parts of the North Sea, and the results of many of those are included in the Tables. The lines chosen were from Leith to the Naze of Norway, Leith to Hamburg, and Leith to the Hook of Holland. Along the first-named lines, the particulars that fall within the present paper are as follows:—On 21st August 1896, a number of floats were thrown overboard at intervals between the Isle of May and the Naze. Up to the distance of 100 miles E. ½ S. of the Isle of May, several of those set adrift were recovered on the coast of Northumberland, after periods which increased according to the distance from the May, ranging from 21 to 161 days. Since then others have been recovered on the coast of Denmark and Sweden—namely, two on the coast of Denmark, near Nymindegab, after intervals of 325 and 340 days, and two near Stromstad, on the west coast of Sweden, on 20th and 26th January 1898, after intervals of 517 and 523 days. Of those put out on this voyage at a distance greater than 100 miles from the Isle of May, only two have been recovered; one, set adrift at 130 miles, found after 150 days at the Lofoten Islands, 740 miles distant, and showing a drift at the rate of 4·9 geographical miles in the 24 hours; the other, set adrift at 250 miles, found also on the coast of Norway, much further to the south (Bömmel Island, S. Bergenhus), after an interval of 55 days and showing an apparent drift of 2·6 geographical miles per day.

The second series on this route were dispersed on the 23rd October 1896. Two of those set adrift 50 miles E. ½ S. from the May Isle were found 93 days later on the coast of Durham; three at 75 miles were recovered, one after 326 days on the west coast of Denmark, and the other two on the west coast of Sweden after the lapse of 341 and 428 days respectively. Of those set adrift at 100 miles, none have been recovered from the English coast; one was found at the Shetland Isles 153 days after, one on the west coast of Denmark after 263 days, and a third near Stavanger, on the coast of Norway, after 315 days. The aberrant case of the Shetland drifter was no doubt due to the remarkable reversal of the current in January 1897.*

* *Ibid* p. 361.

The third series was thrown into the sea on 6th November 1896. Of the five bottles put away at 10 miles from May Isle none have been returned to me. Of five set adrift at 130 miles, one was found on 6th September 1897, near Bergen, Norway; of five at 150 miles, one was picked up after 118 days at Sulen, Sognefjord, Norway, another at the same place four days later, and a third, after 129 days, near Slattero, Norway. Two of the five set adrift at 250 miles have been recovered; one at Trœnen, Nordland, Norway, 620 miles away, after 108 days (showing a drift-rate of 5·7 geographical miles), and the other at Blomvag, near Bergen, after an interval of 203 days.

The fourth series, sent adrift on 25th and 26th December 1896, has given much fuller results. Of 120 bottles used, 39 have been recovered, and, with the exception of one found at Shetland (due to the reversal of the current), all were picked up on the coast of Norway (32), Denmark (2), or Sweden (4); the earliest to be found were those put away at 250 miles, several of which were got in the neighbourhood of Stavanger within a week. The nearest point to May Isle at which the bottles were set adrift was 30 miles; two of these were recovered on the west coast of Denmark in July and August in the following year; one, a little later, at Sulen, Norway, and a fourth in December 1897, on the west coast of Sweden. Of the twenty set adrift at 100 miles, four have been recovered; one at Risör, Norway, on 30th March 1897, after an interval of 96 days; one near Lysekil, Sweden, after 170 days; one near Bergen, Norway, after 186 days, and the fourth near Stromstad, Sweden, on 20th January 1898, the interval being 390 days. Only one was recovered from the lot put away at 150 miles; it was found on 9th April 1897 (after 104 days) at Fetlar, Shetland, carried there, and stranded, by the reversed current referred to. Ten of the twenty set adrift at 200 miles were recovered, all found on the Norwegian coast between Sulen Island, N. Bergenhus, and Egersund, and mostly about Stavanger, towards the end of February and in the beginning of March, after intervals of from 56 to 67 days. Ten were also recovered of the twenty at 250 miles; nine of them in the same area as the above, from the beginning of January to the middle of February, the periods varying from six days to 55 days; one was picked up much further north, on 16th April 1897, after 111 days, near Molde, Romsdal. Nine of the twenty put away at 300 miles, or a point about 32 miles west of the Naze, on 27th December 1896, were recovered, all on the Norwegian coast. Five were discovered at the end of February in the neighbourhood of Bergen and Jæderen; one on 3rd March (67 days), near Molde; one on 16th April (112 days), near Egersund, S. Norway; one on 20th July at Rödö, Helgeland, and one on 30th September 20 kilometres south-south-east of Haugesund.

On the route between the Firth of Forth and Hamburg, series were set adrift on 15th and 16th August, 18th October, and 23rd and 24th December 1896. In the August series, one, put away at 13 miles S.S.E. of May Isle, was found on 19th May 1897, after 276 days, at Hillerslev, Denmark; one, at 20 miles, on 26th June, twelve miles east of Hantsholm, Denmark; one at 30 miles 27 days later, on 11th September 1896, at Blyth, Northumberland, and another of those at 30 miles, on 29th June 1897, after 317 days, 44 kilometres north of Bergen. Some of those put away at 130, 150, and 200, 250, and 300 miles were found at intervals of from 44 to 200 days, on the south and south-west coasts of Norway, on the west coast of Sweden, and the Christianiafjord.

Of fifty bottles thrown into the sea along this route on 18th October 1896, 17 were recovered. Four of the five set adrift at 20 miles S.E. by S. of May Isle were stranded on the Berwick and Northumberland coast within a few days; six of the ten at 30 and 50 miles were got on

the coast of Yorkshire in from 14 to 16 days; one at 70 miles was picked up on the coast of Northumberland after 99 days; one, at 100 miles, was found at Manö, Jutland, on 11th August 1897, after 297 days; two at 130 miles were recovered, one on the coast of Northumberland, after 98 days—probably brought back by the reversed current—and one on 30th July 1897, after 285 days, on the Danish coast. One from each of the lots set adrift at 150, 200, 250, and 300 miles (the latter point about 74 miles west of Heligoland) were subsequently found. The one from 200 miles was caught in a trawl net 100 miles E. by N. of Spurn Point, Yorkshire. That from 150 miles was got on the Danish coast of the Skagerack on 28th September 1897; the one from 250 miles was found at Ringkjöbing, on the west coast of Denmark, in July; and that from 300 miles, at Jædern, Norway, on 26th February, after 131 days.

In the December series 120 bottles were used, of which 50, or nearly 48 per cent., were recovered. Seven of the twenty set adrift at 60 miles from May Isle were found on the island of Sylt, Schleswig, on the coast of Denmark, and the west coast of Sweden, from 31st July to 30th August 1897, the periods varying from 221 to 251 days; the one that went furthest—to the Bohuslän coast, Sweden, was picked up after 240 days. Two others of this lot were got later, in November and December, after 329 and 359 days, at the mouth of the Christianiafjord. Thirteen of the twenty set adrift at 100 miles were recovered, three off the Schleswig coast on 31st July and 12th and 13th August 1897, and the remainder in August and the first two days of September, on the west coast of Denmark. Six from 200 miles were found; one on 10th April 1897, at Sumburgh, Shetland, one on 28th October on the Danish shore of the Skagerack, one on the 30th of the same month, near Stromstad, Sweden, and the others on the coast of Norway, one near Bergen on 19th September, one on 28th October, after 309 days, further north, near Askevold, N. Berghus, the third on 20th March 1898, near Aalesund, Romsdal. Of those set adrift at 250 miles, seven were recovered; one, on 10th August 1897, at Harboore on the Danish coast; two on the west coast of Sweden on 18th September and 28th December; and the others in Norway in September, October, and December, between Kragerö and Udsire, off the Bukkefjord. Five of those set adrift at 300 miles were found in August and September 1897, four on the south and south-west coast of Norway, and one on the west coast of Sweden. Of twenty set adrift at 350 miles—about 24 miles west of Heligoland—ten were recovered; the first 16 days later at the Horn, Denmark; two others in July and August, also on the Danish coast; one on the west coast of Sweden in August, and six on the south-west coast of Norway in May, June, July, November, and December 1897.

The results, then, of this further information as to the surface-drift of the water of the North Sea are in agreement with the conclusions stated in my previous paper. The Atlantic water coming into the North Sea passes down the east coasts of Scotland and England to about the neighbourhood of the Wash; it then crosses towards the coast of Schleswig and Denmark and passes northwards to the south coast of Norway, and thence northwards along the west coast of Norway. Sometimes it passes into the Skagerack to the coast of Sweden and the Christianiafjord.

The value of the above drift-bottle observations is discussed in a recent work by Professor Otto Pettersson of Stockholm, dealing with the hydrography of the North Atlantic.*

* Die hydrographischen Untersuchungen des Nordatlantischen Ozeans in den Jahren, 1895-1896. *Petermann's Geogr. Mitteil*, 1900, Heft. 1., II.

TABLE SHOWING PARTICULARS OF DRIFTERS.

Date and Position where set Adrift.			No.	Date and Position where Recovered.		*Minimum Distance travelled in Geog. Miles.	Time between setting away and Recovery. Days.	Number previously Recovered of same Lot.
Date.	Number of Bottles.	Position.		Date.	Position.			
1894. 5 Nov.	20	8 miles S.E. of Buchan Ness,	503	20 Nov. '99	Fröya Island, S. Trondhjem, Norway,	480	1840	4
1895. 2 Aug.	10	Station VIII., Moray Firth,	504	17 Dec. ,,	2 miles W. of Mandal, S. Norway,	320	1597	2
1896. 22 July	10	½ mile S.E. of Bell Rock,	505	1 Nov. '97	Engel Island, Nordland, Norway,	.	467	5
,, ,,	10	10½ miles S.E. of Bervie,	506	1 April ,,	Jæderens Rev, 21 miles S. of Stavanger, Norway,	280	252	1
.	.	. . .	507	15 May ,,	Blom. Herlo, 5 miles from Bergen, Norway,	310	297	.
,, ,,	10	6 miles S.E. of Girdleness,	508	1 July ,,	Near Hirtshals Light, Denmark,	380	344	1
,, ,,	10	4 miles S.E. of Buchan Ness,	509	5 May ,,	Wangsaa, 8 miles S. of Hantsholm, Denmark,	315	287	5
.	.	. . .	510	3 Aug. ,,	Udvaar Oerne, between Christiansand and Mandal, Norway,	285	377	.
,, ,,	10	8 miles N.N.E. Troup Head, Banffshire,	511	12 July ,,	1 mile (Danish) S. of Thyboron Kanal, near Harboore, Denmark,	330	355	3
.	.	. . .	512	,, ,, ,,	Near Rinkjöbing, Denmark,	345	355	.
,, ,,	10	8 miles N.N.E. of Scarnose Point, Banffshire,	513	21 Oct. ,,	3 miles S. of Strömstad, Hæstersund, Sweden,	430	456	3
30 ,,	10	Lat. 61° 1′ N., long. 3° 13′ W.,	514	22 April ,,	Purköen, Vinjevaagen, Nordland, Norway,	700	266	1
,, ,,	.	,, ,, ,, ,,	515	29 May ,,	Stappen Island, North Cape, Norway,	930	312	.
4 Aug.	15	Lat. 61° 18½′ N., long. 4° 21½′ W.,	516	3 Aug. ,,	Rödö, Helgeland, Norway,	.	365	1
6 ,,	20	Lat. 60° 2′ N., long. 7° 4′ W.,	517	14 Mar. '98	Mousa Island, Shetland,	200	587	5
,, ,,	.	,, ,, ,, ,,	518	4 Nov. '97	Veiholmen, Romsdal, Norway,	420	455	.
		Between May Isle and Hamburg.						
15 ,,	5	13 miles S.S.E. of May Isle,	519	19 May '97	Vigsobugten, Hillerslev, Denmark,	.	278	.
,, ,,	5	20 miles S.S.E. of May Isle,	520	26 June ,,	12 miles E. of Hantsholm, Denmark,	330	306	.
,, ,,	5	30 miles S.S.E. of May Isle,	521	20 ,, ,,	Skjaldoen, 44 kilom. N. from Bergen, Norway,	360	309	1
		Between May Isle and the Naze of Norway.						
21 ,,	5	10 miles E. ½ S. of May Isle.	522	27 July ,,	Husby, Nymindegab, Denmark,	320	340	2

*The distance stated is approximate.

TABLE SHOWING PARTICULARS OF DRIFTERS—*continued.*

Date and Position where set Adrift.			No.	Date and Position where Recovered.		Minimum Distance travelled in Geog. Miles.	Time between setting away and Recovery. Days.	Number previously Recovered of same Lot.
Date.	Number of Bottles.	Position.		Date.	Position.			
1896. 21 Aug.	5	20 miles E. ¼ S. of May Isle,	523	12 July '97	Vangsaa, Hundborg, Denmark,	330	325	.
,, ,,	5	30 miles E. ¼ S. of May Isle,	524	22 June ,,	Bjerregaard, Nymindegab, Denmark,	320	305	.
,, ,,	.	,, ,, ,, ,,	525	20 Jan. '98	Sydkoster, Strömstad, Sweden,	450	517	.
,, ,,	5	50 miles E. of May Isle,	526	26 ,, ,,	Maskar, near Koster, Strömstad, Sweden,	430	523	1
13 Oct.	10	4 miles S.E. of Stonehaven,	527	12 July '97	3½ miles N. of Nymindegab, Denmark,	335	273	3
,, ,,	10	5 miles S.E. of Girdleness,	528	11 ,, ,,	W. side of Römo, N. Schleswig,	370	272	1
,, ,,	.	,, ,, ,, ,,	529	16 May ,,	Sondervig, Ringkjöbing, Denmark,	330	216	.
,, ,,		,, ,, ,, ,,	530	6 Aug. ,,	Near Varde, Ribe, Denmark,	310	298	.
,, ,,	.	,, ,, ,, ,,	531	7 July ,,	Rögö, Fjellbacka, Skagerack, Sweden,	430	268	.
14 ,,	10	4 miles S.E. of Buchan Ness,	532	8 ,, ,,	Alnmouth, Northumberland,	110	268	0
,, ,,	.	,, ,, ,, ,,	533	11 Dec. ,,	1 mile N. of Lodberg Light, Denmark,	320	424	.
		Between May Isle and Hamburg.						
1896. 18 Oct.	10	100 miles S.E. by E. of May Isle.	534	11 Aug. ,,	Manö, Jutland, Denmark,	240	298	.
,, ,,	5	130 miles S.E. by E. of May Isle,	535	30 July ,,	10 miles N. of Nymindegab, Denmark,	230	256	1
,, ,,	5	150 miles S.E. by E. of May Isle.	536	28 Sept. ,,	Raabjerg, Skagerak, Denmark,	280	346	.
,, ,,	5	250 miles S.E. by E. of May Isle.	537	12 July ,,	Vesterhavet, Ringkjöbing, Denmark,	140	268	.
,, ,,	5	300 miles S.E. by E. of May Isle,	538	26 Feb. ,,	Reime, Obristad Light, Jæderen, Norway,	220	132	.
		Between May Isle and the Naze of Norway.						
23 ,,	5	75 miles E. ½ S. of May Isle,	539	13 Sept. ,,	Klitmoeller, 3 miles S. of Hanstholmen, Denmark,	270	326	.
,, ,,	.	,, ,, ,, ,,	540	28 ,, ,,	Vorra Hamnen, Lysekil, Sweden,	380	341	.
,, ,,	.	,, ,, ,, ,,	541	24 Dec. ,,	Hono Island, near Göteborg, Sweden,	380	428	.
,, ,,	10	100 miles E. ½ S. of May Isle,	542	24 Mar. ,,	Sandwick Bay, Shetland,	210	153	.
,, ,,	.	,, ,, ,, ,,	543	12 July ,,	W. side Sanneshage, Jutland, Denmark,	260	263	.

TABLE SHOWING PARTICULARS OF DRIFTERS—*continued.*

Date and Position where set Adrift.			No.	Date and Position where Recovered.		Minimum Distance travelled in Geog. Miles.	Time between setting away and Recovery. Days.	Number previously Recovered of same Lot.
Date.	Number of Bottles.	Position.		Date.	Position.			
1896. 23 Oct.	.	100 miles E. ¼ S. of May Isle,	544	2 Sept. '97	Obrestad Lighthouse, Naerbo, near Stavanger, Norway,	210	315	.
6 Nov.	5	130 miles E. ¼ S. of May Isle,	545	6 ,, ,,	Ronglevar, 5 miles N. of Bergen, Norway,	250	273	.
,, ,,	5	150 miles E. ¼ S. of May Isle,	546	8 Mar. ,,	Sulen Island, N. of Bergen, Norway,	275	122	1
,, ,,	.	,, ,, ,, ,,	547	15 ,, ,,	Goddehavn, 2 miles S. of Slattero Light, Norway,	.	129	.
7 ,,	5	250 miles E. ¼ S. of May Isle.	548	29 May ,,	Blomvaag, near Bergen, Norway,	180	172	1
		Between Leith and the Hook of Holland.						
1 Nov.	7	46 miles N.E. by E. of Cromer, Norfolk,	549	6 April ,,	Thorupstrand, Thisted, Denmark,	300	157	1
,, ,,	.	,, ,, ,, ,,	550	18 May ,,	Near Husby, Ringkjöbing, Denmark,	260	199	.
,, ,,	8	57 miles E. ½ S. of Cromer,	551	2 April ,,	30 miles E. of Hantsholm, in the Jammerbugt, Denmark,	310	153	.
,, ,,	.	,, ,, ,, ,,	552	5 June ,,	Landö, East of Mandal, Norway,	330	217	.
,, ,,	8	57 miles E. by N. ½ E. of Lowestoft,	553	27 ,, ,,	Blokhus, Denmark,	320	239	.
,, ,,	8	37 miles N. by W. of Scheveningen, Holland,	554	9 May ,,	Oester Klit, near Sindal,	.	190	.
,, ,,	.	,, ,, ,, ,,	555	8 July ,,	Thorsminde, Jutland, Denmark,	230	250	.
,, ,,	.	,, ,, ,, ,,	556	7 ,, ,,	6 miles N. of Nymindegab, Denmark,	.	249	.
		Between the Isle of May and the Naze of Norway.						
25 Dec.	20	30 miles E. of May Isle,	557	9 ,, ,,	1 mile S. of Agger, near Vestervig, Denmark,	320	197	.
,, ,,	.	,, ,, ,, ,,	558	24 Aug. ,,	Lodbjerg Light, near Agger, Denmark,	320	243	.
,, ,,	.	,, ,, ,, ,,	559	28 ,, ,,	Kinn, near Sulen, Norway,	350	247	.
,, ,,	.	,, ,, ,, ,,	560	30 Dec. ,,	Near Karingo, Bohuslän, Sweden,	430	370	.
,, ,,	20	100 miles E. of May Isle,	561	30 Mar. ,,	1 mile W. of Risör, Norway,	310	96	.
,, ,,	.	,, ,, ,, ,,	562	14 June ,,	Stora Kornö Island, near Lysekil, Sweden,	360	172	.

TABLE SHOWING PARTICULARS OF DRIFTERS—*continued.*

Date and Position where set Adrift.			No.	Date and Position where Recovered.		Minimum Distance travelled in Geog. Miles.	Time between setting away and Recovery. Days.	Number previously Recovered of same Lot.
Date.	Number of Bottles.	Position.		Date.	Position.			
1896. 25 Dec.	.	100 miles E. of May Isle,	563	1 July '97	Humlekärr. 6 miles N.E. of above, Sweden,	360	189	.
,, ,,	.	,, ,, ,, ,,	564	27 Sept. ,,	Stolmöen, near Bergen, Norway,	240	277	.
,, ,,	.	,, ,, ,, ,,	565	20 Jan. '98	Lindholmen, S. of Strömstad, Sweden,	360	392	.
25 ,,	.	150 ,, ,, ,,	566	9 April '97	Airth, Fetlar, Shetland,	200	100	.
26 ,,	20	200 ,, ,, ,,	567	2 Mar. ,,	Maskerö, near Stavanger, Norway,	110	67	9
,, ,,	20	250 ,, ,, ,,	568	7 Mar. '98	Rakvaag, Akero, near Molde, Norway,	330	72	9
,, ,,	20	300 ,, ,, ,, (about 32 miles W. of the Naze of Norway),	569	16 April '97	8 miles S. of Egersund, Norway,	30	112	6
,, ,,	.	,, ,, ,, ,,	570	20 July ,,	Valvœr, Rödö, Helgeland, Norway,	600	207	.
,, ,,	.	,, ,, ,, ,,	571	30 Sept. ,,	20 kilom. S.S.E. of Haugesund, Norway,	80	279	.
		Between the Isle of May and Hamburg.						
23 Dec.	20	60 miles from May Isle,	572	31 July ,,	Island of Sylt, Schleswig,	320	221	.
,, ,,	.	,, ,, ,, ,,	573	14 Aug. ,,	Harboore, Denmark,	300	235	.
,, ,,	.	,, ,, ,, ,,	574	18 ,, ,,	Bjergehuse, Denmark,	.	239	.
,, ,,	.	,, ,, ,, ,,	575	19 ,, ,,	Island of Sylt, Schleswig,	320	240	.
,, ,,	.	,, ,, ,, ,,	576	19 ,, ,,	Längeskar, Hafstensund, Bohuslän, Sweden,	430	240	.
,, ,,	.	,, ,, ,, ,,	577	26 ,, ,,	1 mile N. of Horus Rev, near Varde, Denmark,	310	247	.
,, ,,	.	,, ,, ,, ,,	578	30 ,, ,,	Kjettrupgaard, Blokhus, Denmark,	350	253	.
,, ,,	.	,, ,, ,, ,,	579	18 Nov. ,,	Langöen, Vigsfjord, W. of Farder, Norway,	420	331	.
,, ,,	.	,, ,, ,, ,,	580	18 Dec. ,,	Onso, near Fredrikstad, Norway,	430	361	.
,, ,,	20	100 ,, ,, ,,	581	31 July ,,	Westerland, Sylt Island. Schleswig,	270	221	.
,, ,,	.	,, ,, ,, ,,	582	13 Aug. ,,	Near Kampen, Sylt, Schleswi	270	234	.
,, ,,	.	,, ,, ,, ,,	583	12 ,, ,,	Wijk, Föhr Island, Schleswig,	275	233	.
,, ,,	.	,, ,, ,, ,,	584	13 ,, ,,	Haurvig, Jutland, Denmark,	250	234	.

TABLE SHOWING PARTICULARS OF DRIFTERS—*continued.*

Date and Position where set Adrift.			No.	Date and Position where Recovered.		Minimum Distance travelled in Geog. Miles.	Time between setting away and Recovery. Days.	Number previously Recovered of same Lot.
Date.	Number of Bottles.	Position.		Date.	Position.			
1896. 23 Dec.	.	100 miles from May Isle,	585	17 Aug. '97	10 miles N. of Nymindegab, Denmark,	250	238	.
,, ,,	.	,, ,, ,, ,,	586	17 ,, ,,	Klegod, Jutland, Denmark,	250	233	.
,, ,,	.	,, ,, ,, ,,	587	18 ,, ,,	8 miles N. of Nymindegab, Denmark,	250	239	.
,, ,,	.	,, ,, ,, ,,	588	18 ,, ,,	Nordby, Fanö Island, Denmark,	270	239	.
,, ,,	.	,, ,, ,, ,,	589	20 ,, ,,	17 miles N. of Nymindegab, Denmark,	260	241	.
,, ,,	.	,, ,, ,, ,,	590	20 ,, ,,	7 miles N. of Ringkjöbing, Denmark,	250	241	.
,, ,,	.	,, ,, ,, ,,	591	20 ,, ,,	9 miles N. of Nymindegab, Denmark,	250	241	.
,, ,,	.	,, ,, ,, ,,	592	25 ,, ,,	Sonderho, Fanö Island, Denmark,	270	246	.
,, ,,	.	,, ,, ,, ,,	593	2 Sept. ,,	Vedsted, 7 miles S.W. of Ribe, Denmark,	270	254	.
,, ,,	20	200 ,, ,, ,,	594	10 April ,,	Upper end West Voe of Sumburgh, Shetland,	310	108	.
,, ,,	.	,, ,, ,, ,,	595	19 Sept. ,,	Lönöen, Fjeld, near Bergen, Norway,	300	271	.
,, ,,	.	,, ,, ,, ,,	596	28 Oct. ,,	Inside Hindo Island, near Askevold, N. Berghus, Norway,	360	310	.
,, ,,	.	,, ,, ,, ,,	597	28 . ,,	Skiveren, Raabjerg, Horns Herred, Skagerak, Denmark,	270	310	.
,, ,,	.	,, ,, ,, ,,	598	10 Dec. ,,	Onsöen, 2 miles E. of Lillesand, Norway,	250	353	.
,, ,,	.	,, ,, ,, ,,	599	30 ,, ,,	2 miles S.W. of Strömstad, Sweden,	340	342	.
,, ,,	.	,, ,, ,, ,,	600	20 Mar. '98	Fjortofr, Aalesund, Sondmore, Norway,	440	453	.
,, ,,	.	250 ,, ,, ,,	601	10 Aug. '97	Harboöre, near Lemvig, Denmark,	160	231	.
,, ,,	.	,, ,, ,, ,,	602	13 Sept. ,,	N. side of Udsire Island, 20 miles W. of Haugesund, Norway,	250	265	.
,, ,,	.	,, ,, ,, ,,	603	18 ,, ,,	1½ Swedish miles S. of Fjellbaka, Sweden,	310	270	.
,, ,,	.	,, ,, ,, ,,	604	13 Oct. ,,	Risevigen, Tananger, Stavanger, Norway,	250	295	.
,, ,,	.	,, ,, ,, ,,	605	18 ,, ,,	N. of Haugesund, at Bommelfjord, Norway,	260	300	.
,, ,,	.	,, ,, ,, ,,	606	3 Dec. ,,	Straaholmen, 4 miles N. of Jamfurlands Light, near Kragero, S. Norway,	280	346	.

TABLE SHOWING PARTICULARS OF DRIFTERS—*continued.*

Date and Position where set Adrift.			No.	Date and Position where Recovered.		Minimum Distance travelled in Geog. Miles.	Time between setting away and Recovery. Days.	Number previously Recovered of same Lot.
Date.	Number of Bottles.	Position.		Date.	Position.			
1896. 23 Dec.	.	250 miles from May Isle,	607	28 Dec. '97	Räaso Island, near Strömstad, Sweden,	330	370	.
24 ,,	20	300 ,, ,, ,,	608	1 Aug. ,,	Fiskeback, near Göteborg, Sweden,	290	220	.
,, ,,	.	,, ,, ,, ,,	609	17 ,, ,,	2 miles N. of Noshavn Tysnœsoen, near Bergen, Norway,	340	237	.
,, ,,	.	,, ,, ,, ,,	610	28 ,, ,,	Homborgsund, near Lillesand, S. Norway,	220	248	.
,, ,,	.	,, ,, ,, ,,	611	4 Sept. ,,	Ona, near Molde, Norway,	400	255	.
,, ,,	.	,, ,, ,, ,,	612	9 ,, ,,	Ulvosund, 20 kilom. E. of Christiansand, S. Norway,	230	260	.
,, ,,	.	350 ,, ,, ,, (about 24 miles W. of Heligoland)	613	20 May ,,	Klaksöen, W. of Stordöen, S. Bergenhus, Norway,	320	147	1
,, ,,	.	,, ,, ,, ,,	614	10 June ,,	½ mile W. of Bulbjerg, near Bjerget, Norway,	.	167	.
,, ,,	.	,, ,, ,, ,,	615	22 July ,,	Tranum, Rödhus, Aabybro, Norway,	.	208	.
,, ,,	.	,, ,, ,, ,,	616	18 ,, ,,	Hermö, near Bergen, Norway,	350	204	.
,, ,,	.	,, ,, ,, ,,	617	31 ,, ,,	Harboore Sojn, Ringkjöbing, Denmark,	110	218	.
,, ,,	.	,, ,, ,, ,,	618	25 Aug. ,,	Fjellbacka, Bohuslän, Sweden,	300	212	.
,, ,,	.	,, ,, ,, ,,	619	23 ,, ,,	3 miles E. of Hanstholmen, Denmark,	160	210	.
,, ,,	.	,, ,, ,, ,,	620	20 Nov. ,,	Nœsvig Tellevaager, Nordhordland, 6 miles from Bergen, Norway,	350	330	.
,, ,,	.	,, ,, ,, ,,	621	10 Dec. ,,	Sartör, 20 miles W. by N. of Bergen, Norway,	350	350	.
28 Dec.	10	Off Girdleness, Aberdeenshire,	622	13 ,, ,,	Sanday Island, Orkney,	130	350	2
29 ,,	10	50 miles S. by W. of Copinsha Isle, Orkney,	623	4 April ,,	Meal, Cunningsburgh, Shetland,	130	97	1
		Between Isle of May and Hook of Holland.						
1897. 3 Jan.	20	46 miles N.E. by S. of Cromer, Norfolk,	624	31 Mar. ,,	Risberg, 10 miles S. of Hirtshals, Denmark,	350	87	.
,, ,,	20	32 miles N. by W. of Hook,	625	5 April ,,	1 mile W. of the Skaw, Denmark,	300	92	5
,, ,,	.	,, ,, ,, ,,	626	3 May ,,	Solost Rocks, Tysver, Stavanger, Norway,	300	120	.
17 ,,	10	50 miles S.S.W. of Bressay Light, Shetland,	627	26 Oct. ,,	Rosöen, Kvitingsö, near Stavanger, Norway,	200	282	.

TABLE SHOWING PARTICULARS OF DRIFTERS—*continued.*

Date and Position where set Adrift.			No.	Date and Position where Recovered.		Minimum Distance travelled in Geog. Miles.	Time between setting away and Recovery. Days.	Number previously Recovered of same Lot.
Date.	Number of Bottles.	Position.		Date.	Position.			
1897. 17 Jan.	.	50 miles S.S.W. of Bressay Light, Shetland,	628	10 Nov. '97	Ingöen, 7 miles from Hammerfest, Norway,	900	297	.
,, ,,	.	,, ,, ,, ,,	629	18 Feb. '98	Godden, Finaas, 60 km. S. of Bergen, Norway,	190	397	.
,, ,,	10	100 miles S.S.W. of Bressay Light,	630	14 Sept. '97	4 miles E. of Hirtshals Light, Denmark,	350	240	.
,, ,,	.	,, ,, ,, ,,	631	15 ,, ,,	Komelsfjord, near Christiansand, Norway,	290	241	.
,, ,,	.	,, ,, ,, ,,	632	23 Nov. ,,	Randöen, near Christiansand, Norway,	290	310	.
,, ,,	.	,, ,, ,, ,,	633	5 Feb. '98	Straaholmen Island, near Kragero, S. Norway,	340	385	.
10 Feb.	100	4 miles E. of Isle of May, Firth of Forth,	634	*27 April '97	Got in a trawl net 6 miles E. of May,	2	76	.

* This is the only bottle recovered of 100 put away on this occasion; all were weighted to go to the bottom.

XI.—NOTES ON SOME GATHERINGS OF CRUSTACEA COLLECTED FOR THE MOST PART ON BOARD THE FISHERY STEAMER "GARLAND" AND EXAMINED DURING THE PAST YEAR (1899).

By THOMAS SCOTT, F.L.S., Mem. Zool. Soc. de France.

(Plates XIII. and XIV.)

The following "Notes" are intended to supplement a somewhat similar series published in Part III. of the *Seventeenth Annual Report*. These notes deal entirely with the Crustacea, and refer to species that have been observed in various gatherings of tow-net and dredged materials examined during the past year, and collected for the most part on board the "Garland." The majority of the species referred to have been obtained in gatherings collected in Loch Fyne and in the seaward portion of the Firth of Clyde, but a few are also from other parts of the Scottish coasts; moreover, with the exception of one or two brackish-water forms those recorded are all marine species.

A few of the copepods mentioned in the sequel are apparently undescribed, but most of the other forms have already been recorded. Further information concerning these has, however, been obtained bearing on their structural details or on the distribution of the species, which it will be of interest to notice.

My son, Mr. Andrew Scott (assisted by Mrs. Scott), has prepared drawings to illustrate where necessary the various objects described. Several forms other than those mentioned in the sequel have had to stand over, but these will be described later.

COPEPODA.

Eucalanus crassus, Giesbrecht.

1888. *Eucalanus crassus*, Giesb., Atti Acc. Lincei, Rend. (4), vol. iv,, sem. 2, p. 333.

A considerable number of specimens of this species were obtained in a bottom tow-net* gathering collected in Dornoch Firth, November 19th, 1898. The depth at which the tow-net was worked varied from 8 to 16 fathoms. A large proportion of the specimens obtained were more or less immature. This *Eucalanus* has been obtained in the Moray Firth district on several occasions during the past few years, but it was apparently more frequent in the present gathering than in any of those previously examined. It is somewhat difficult to distinguish the immature forms of the species, but the adults are comparatively easily distinguished. When it is remembered that the distribution of *Eucalanus crassus* extends south as far at least as the Gulf of Guinea, its presence in the Moray Firth from time to time is of more than usual interest.

* What is here called the "bottom tow-net" is the tow-net that is fastened to the trawl-head in such a way that when the trawl is working the tow-net just clears the sea-bottom.

Eucalanus elongatus (Dana).

1849. *Calanus elongatus*, Dana, Proc. Amer. Acad., vol. ii, p. 18.

A single specimen—a female—was obtained in the same gathering with the last. This is a larger species than *Eucalanus crassus*; the specimen referred to here measured fully 6mm. in length (about a quarter of an inch). In this species the last thoracic segment has the sides produced posteriorly into short pointed processes. The presence of *Eucalanus elongatus* in the Moray Firth is also of interest as bearing on the question of the distribution of species. These copepods are probably carried into the estuary by regular tidal currents or by temporary currents set up by the wind, should it happen to blow from one particular direction for a more or less lengthened period.

Neither of the two species named have yet been observed in the Firth of Forth or the Firth of Clyde. These two estuaries, though extending for a considerable distance inland, are comparatively narrow, and the entrance to each is obstructed to some extent by an island; the Moray Firth, on the other hand, presents an extensive opening to the North Sea and narrows very gradually westwards. Such a difference in the general contour of these inlets has probably a more or less distinct influence on the distribution of their local faunas.

Paracalanus parvus (Claus).

1863. *Calanus parvus*, Claus, Die freileb. Copep., p. 173, Pl. XXVI., figs. 10–14; Pl. XXVII, figs. 1–4.

This small species has been observed in gatherings collected during the past year both in the Clyde and Loch Fyne, and usually in bottom tow-net gatherings. It was, for example, observed in a bottom-gathering from Station V. (Whiting Bay, Arran), collected September 8th, and in another from Station XVII. (near the head of Loch Fyne), collected September 29th.

Stephus fultoni, T. and A. Scott.

1898. *Stephus fultoni*, T. and A. Scott, Ann. and Mag. Nat. Hist. (7). vol. i., p. 185, Pl. X., figs. 1–8; Pl. II., figs. 1–4.

Stephus fultoni has apparently not yet been observed outside the Clyde area. It was first observed in 1896 in some material dredged in Kilbrennan Sound, and subsequently in a small gathering of crustacea collected near the Spit, Loch Fyne, in 1897. I have now to record its occurrence for the second time at this Loch Fyne Station; the material in which it was obtained on the present occasion was collected during the early part of this year (1899), and a few specimens only were observed. *Stephus fultoni*, which seems to be a rare species, is comparatively easily distinguished from the other members of the genus by the somewhat larger size of the female and by the male having the fifth thoracic feet conspicuous and furnished with horn-coloured processes.

Bradyidius armatus (Vanhöffen).

*1897. *Bradyanus armatus* (Vanhöffen in:) Chun, Arkt. antarkt. Plankton, p. 28.

It was pointed out in my "Notes" last year that *Bradyidius armatus* was one of the more widely diffused of the Clyde copepods, and that it was also occasionally observed on the East Coast. During the past year

* *Vide* Das Tierreich, p. 32.

it has again been observed in several of the gatherings sent to the Fishery Board's Laboratory from the Clyde. In 1897 a new genus was instituted for this copepod by Dr. W. Giesbrecht, of Naples, but it appears to be one of those species whose lot it is to undergo several removals ere it reaches its ultimate destination, as indicated by the following quotation from a work lately published by Herr. O. Nordgaard, entitled, "Report on Norwegian Marine Investigations, 1895–97." At page 21 of his report, Herr. Nordgaard refers to the species under consideration as follows:—

"In 'Undersögelser over Dyrelivet i Arktiske Fjorde' Herr Sparre Schneider has mentioned a copepod that is called *Undinopsis bradyi*, G. O. Sars. This species is said to have been found in Kvænangen and at Tromsö. In the summer of 1897 I showed Professor Sars a preparation of a copepod that I was unable to identify. He then declared it to be the very *Undinopsis bradyi*, and afterwards informed me in a letter that the said copepod had been described by Mr. Brady (Monograph of the Copepoda of the British Islands, i., p. 46, Pl. IV., figs. 1–11).

The species was, however, there wrongly identified with *Pseudocalanus armatus*, Boeck, which, according to Mr. Sars, is another species. As Mr. Sars in his gigantic revision of Norwegian Crustacea will soon come to the Copepoda, I shall do nothing but here note the occurrence of *Undinopsis bradyi* at the following places:—

March 14th, 1896, Vestfjord (67° 32·5′ N.; 130° 24·5′ E.) in Plankton 0·200m.

March 5th, 1897; Ostnes-fjord in Lofoten.

March 7th, 1897, Irold-fjord in Lofoten, Plankton 0·65m.

Besides, I have this year (1899) taken several specimens of the species in fjords near Bergen."

This note by Herr. Nordgaard is of interest, if for nothing else than the information he gives concerning the distribution of the species, but it also indicates that Professor Sars' designation is likely to take precedence over that of *Bradyidius armatus* of Drs. Giesbrecht and Vanhöfen. It is doubtful, however, if this copepod will be allowed to rest under *Undinopsis bradyi*, for it is by no means a rare species, and, as Herr. Nordgaard and Professor Sars have shown, it has a wide distribution. It is probable, therefore, that it has not escaped the notice of some of the earlier naturalists, and may be described and named in their published works by a designation different from any of those referred to.

Isias clavipes, Boeck.

1864. *Isias clavipes*, Boeck, Forh. Vid. Selsk., Christiania, p. 18.

This, which is a moderately rare species, has again been observed in several of the tow-net gatherings forwarded from the Clyde during recent months. The specimens obtained were found for the most part in gatherings collected in the tow-net fixed to the head of the trawl, and appeared to be most frequent in the gatherings collected in September. The species was taken in Kilbrennan Sound at Stations III. and IV., near Sanda Island, and in the vicinity of Ailsa Craig. I have no records of *Isias* from Loch Fyne this year. It may be of interest to mention that it was also during September last year that *Isias* was chiefly observed.

Eurytemora velox (Lilljeborg).

1853. *Temora velox*, Lillj., De Crustac. ex ordin. tribus; Cladoc. Ostrac. et Copep. in Scania occurr., p. 177, Pl. XX., figs. 2–7.

This species was found in a small pond near the New Zoological

Station at Millport, Cumbrae, and also in shore pools at the south-west corner of the island on May 6th, 1899. Professor G. S. Brady obtained the species from Cumbrae many years ago, and it is interesting to find it in the same localities in which it was then observed.

Eurytemora affinis (Poppe).

1880. *Temora affinis*, Poppe, Abhandl. d. Naturw. Ver. Bremen, Bd. vii., pp. 55–60, Pl. III.

I find this species in rock pools near low-water mark at Bay of Nigg, Aberdeen (just in front of the New Laboratory of the Fishery Board for Scotland), where it is not uncommon. It also occurred in a large pool left by the ebbing tide near the bridge where the railway crosses the River Dee. These species of *Eurytemora* require careful examination in order to distinguish the one from the other.

Metridia lucens, Boeck.

1864. *Metridia lucens*, Boeck, Forh. Vid. Selsk., Christiania, p. 14.

This species was moderately frequent in a bottom tow-net gathering of Crustacea collected during the past year in Aberdeen Bay. In the Firth of Clyde, *Metridia lucens* appears to be one of the resident copepods, as it may be obtained there all the year round, though usually in small numbers. The more recent Clyde gatherings in which the species occurred, and of which I have notes, were collected in the bottom tow-net near the seaward part of the estuary.

Paramesophria cluthæ, Th. Scott.

1897. *Paramesophria cluthæ*, Th. Scott, *Fifteenth Rep. Fish. Board Scotl.*, Part III., p. 147, Pl. II., figs. 3–8; Pl. III., figs. 13–16.

This moderately large and distinct species was described from specimens dredged off Largabruach, Upper Loch Fyne, and I have now to record its occurrence at Tarbert Bank (off East Tarbert), Lower Loch Fyne; it was obtained amongst some material dredged from about 17 to 20 fathoms on October 21st, 1899. In one of the more recently published works on the Copepoda (Das Tierreich, Lief. 6), *Paramesophria* takes its place amongst the Centropagidæ.

Labidocera wollastoni (Lubbock).

1857. *Pontella wollastoni*, Lubbock, Ann. and Mag. Nat. Hist. (2), vol. xx., p. 406, Pls. X.–XI.

Last year I recorded this fine species from two Clyde stations, both of which are near the seaward limits of the estuary. This year I have to record its occurrence in a bottom tow-net gathering (12 to 26½ fathoms), collected in the vicinity of Sanda Island, near the mouth of the Clyde, on September 5th, 1899; it was also obtained in a second gathering collected two days later in about 55 fathoms and somewhat further seaward. In a gathering collected in November a number both of males and females were found. This gathering was also from the mouth of the estuary. I also take this opportunity to record *Labidocera wollastoni* from the Firth of Forth. During the past summer I overhauled some tow-net gatherings that had been collected a few years ago, and found that one or two of them had not before been examined; in one collected to the east of

Inchkeith on June 8th, 1891, I found amongst other things a single male specimen of the *Labidocera* referred to. I do not think that this species has been before recorded from the Firth of Forth.

Cyclopina gracilis, Claus.

1863. *Cyclopina gracilis*, Claus, Die frei-leb. Copep., p. 104, Pl. X., figs. 8–15.

Specimens of this small but distinct species were obtained in a gathering of material dredged in the vicinity of Otter Spit, Upper Loch Fyne, during the early part of the year. This gathering contained a large number of comparatively rare copepods, several of which are referred to in the present "Notes."

Notodelphys prasina, Thorell.

1859. *Notodelphys prasina*, Thorell, Bidr. till Känned. om Krustac. i Ascid., p. 46, Pl. V., fig. 7.

This copepod has occurred frequently in Ascidians dredged from Tarbert Bank, Loch Fyne, during recent months. *N. prasina* has very short caudal furca, and by this character alone it may be readily distinguished from the other species of *Notodelphys* hitherto recorded from Scotland. *Notodelphys allmani*, Thorell, is also occasionally found in Clyde Ascidians, but does not seem to be just so common as the species first named.

Doropygus pulex, Thorell.

1859. *Doropygus pulex*, Thorell, op. cit., p. 46, Pl. VI., fig. 8.

A few specimens of this curious species were obtained in Ascidians dredged at Tarbert Bank, Loch Fyne (17-20 fathoms), in October 1899. In this species the caudal furca are "slightly elongate" and "becoming gradually thin, or tapering, towards the distal end" (Canu, Copep. du Boulonn., p. 195). *Doropygus pulex* appears to be somewhat rare in the Clyde area.

Doropygus (?) *gibber*, Thorell.

1859. *Doropygus gibber*, Thorell, op. cit., p. 52, Pl. VIII., fig. 11.

One or two specimens of a *Doropygus*, apparently belonging to this species, were found in some dredged material from Tarbert Bank, Loch Fyne. Dr. Giesbrecht* considers this to be more nearly related to *Notopterophorus* than to *Doropygus*.

Doropygus porcicauda, G. S. Brady.

1878. *Doropygus porcicauda*, Brady, Mon. Brit. Copep., vol. i., p. 138, Pl. XXVII., figs. 1–9; Pl. XXXIII., figs. 14–16.

Several specimens of this large and apparently distinct species were obtained in the same dredged material as the last. In this species the caudal rami are of considerable length, somewhat divergent and more or less curved. It does not seem to be very uncommon in Loch Fyne Ascidians.

Enterocola (?) *fulgens*, Van Beneden. (Pl. XIII., figs. 21-27.)

1860. *Enterocola fulgens*, Van Ben., Bull. Acad. Belg. (2), vol. ix., p. 151, Pl. I.

I have on one or two different occasions found in gatherings of dredged material from the Clyde odd specimens of an *Enterocola* usually of a

* *Mittheil. Zool. Stat. Neapel*, vol. iii., p. 328 (1882).

larger size than either *Enterocola fulgens*, Van Beneden, or *Enterocola betencourti*, Canu, and which to some extent differs also in some of its structural details from both these forms. I prefer, however, in the meantime to regard our specimens as a "form" or variety of Van Beneden's *Enterocola fulgens* rather than institute a new species for their reception.

These Clyde specimens are found in the intestine—not the branchial cavity—of a small Ascidian. Usually only one Copepod is observed in each specimen of the Ascidian in which the parasites occur, and it also usually so fills up the part of the intestine in which it is lodged that it is with difficulty detached with its ovisacs *in situ*, one or both frequently breaking away while removing the Copepod from its environment.

All the specimens of the Copepods obtained as described, and which I have examined, appear to belong to the one species, but they vary greatly in size. The specimen represented by the drawing (fig. 21), measures little more than two millimetres (2·2mm.) in length, whilst another that I have measured extends to at least four millimetres. The ovisacs are of a distinctly reddish colour, so that when examining the Ascidians in which the Copepods occur one can see at a glance and without dissection whether a parasite is present by the red colour of the ovisacs showing itself through the thin wall of the intestine of the host.

The mouth-organs of the *Enterocola* are difficult to make out; they are all simple, and do not show much structure. Figures 22 and 23 represent what appear to be one of the antennules and one of the antennæ. The mouth takes the form of a short and somewhat cone-shaped process. There appears to be no mandibles properly so called, and, according to Dr. Canu, the absence of mandibles is one of the distinctive characteristics of the genus *Enterocola*. The (?) maxillæ (fig. 24) are broad foliaceous appendages, bearing on their distal margin a number of stout ciliated spines. The posterior foot-jaws are very stout, and terminate in very short but strong claw-like processes (fig. 25).

The first four pairs of thoracic feet are all very much alike. They are two-branched; the outer branches appear to be one-jointed, and are moderately stout, and taper towards the distal end; they are also furnished with two moderately long and plumose terminal setæ; the inner branches consist of short, stout, tapering appendages of a simple and almost rudimentary character (figs. 26 and 27). The fifth pair are conspicuous and broadly dilated appendages. The caudal furca are about twice as long as broad. The female carries two ovisacs, which in well grown specimens are about as long as the body of the copepod.

Gunenotophorus (?) *globularis*, Costa. (Pl. XIII., figs. 28–34; Pl. XIV., figs. 37 and 38).

1852. *Gunenotophorus globularis*, Costa, Fauna del Regno di Napoli, Entom. (1840).

A somewhat curious copepod, agreeing in almost every detail of structure with the species described by O. G. Costa under the name of *Gunenotophorus globularis*, was obtained in some dredged material from the vicinity of Sanda Island, Firth of Clyde, in December 1898. The species is said to occur in the branchial cavity of Ascidians, but this Clyde specimen (only one was obtained) occurred free amongst the dredged material, having probably come from a dredged Ascidian.

The entire length of the specimen was about five millimetres (about one-fifth of an inch). The body was considerably dilated, but the abdomen was more slender, and was quite distinct; the whole animal was strongly incurved, as shown by the figure (fig. 28, Pl. XIII). The specimen, which had a somewhat macerated appearance, did not exhibit much segmentation

of the cephalon or thorax, but the abdomen, which was moderately elongated and cylindrical, was divided into four distinct segments, the first three of which were smaller than the last one; the last—or anal segment—was about as long as the combined length of the two that preceded it. The caudal furca were short and very divergent, extending outwards at almost right angles to the abdominal segment (fig. 34, Pl. XIII.). The antennules, which showed very little jointing, were very short and stout except the end joint, which was a small one (fig. 29, Pl. XIII.) The antennæ (fig. 30, Pl. XIII.) were also short and stout, and armed with a moderately strong but short and slightly clawed terminal spine. The mandibles with their palps resembled very closely the figures of these appendages given by Dr. Canu in his interesting work on the marine Copepoda (*Les Copepodes du Boulonnais*, Pl. XI., figs. 3 and 4). The biting part of the mandible is armed with five large teeth, arranged widely apart, and several minute, close-set, and slightly elongated spinules, while the palp ends in two short setiferous branches (fig. 31, Pl. XIII.). The maxillæ are broadly foliaceous, the masticatory lobe is armed with a series of spiniform setæ along the margin, and a number of stout, elongated plumose setæ adorn the margins of the maxilla-palp. The anterior foot-jaws are stout but simple one-jointed appendages furnished with several stout plumose terminal setæ (fig. 37, Pl. XIV.). The posterior foot-jaws (fig. 32, Pl. XIII.) are moderately stout, and armed with a short but comparatively strong terminal claw. There are also a number of setæ on the inner margin of these appendages.

The first pair of thoracic feet (fig. 38, Pl. XIV.) are stout and moderately short; both branches are three-jointed and of nearly the same length, and they are both provided with elongated and densely plumose setæ on the inner margins. The next three pairs, which are somewhat similar to each other, have the inner branches short and slender and apparently three-jointed, while the outer branches, which are also three-jointed, are moderately stout and elongate; neither the inner nor outer branches were observed to carry setæ, their only armature appeared to consist of one or two minute spines. The fifth feet appeared to be obsolete, but this appearance may have been due to the specimen being somewhat imperfect.

When it is remembered that the specimen here described was found free amongst a quantity of mixed dredgings, and not *in situ* in any Ascidian, and that, moreover, from the habitat of the animal its whole structure is more or less flaccid and more liable to injury than the stronger free-swimming forms, it need not be surprising that it should differ to a small extent from the more perfect and better preserved specimens. After a careful study of the characters of this Clyde specimen, I have little doubt that it belongs to the species to which it has been ascribed.

There does not seem to be any previous British record of *Gunenotophorus globularis*, and its occurrence in the Clyde estuary is therefore of interest.

Botryllophilus (?) *ruber*, Hesse.

1864. *Botryllophilus ruber*, Hesse, Ann. Sci. Nat. Zool. (5), t. i., Pl. XII., figs. 1 and 2.

I have noticed two, or perhaps three, specimens of a *Botryllophilus* in some material that was dredged at Tarbert Bank, Lower Loch Fyne, in the vicinity of East Tarbert. The specimens were not found *in situ* within any Ascidian, but were mixed up amongst the debris; their host had probably been damaged by the lip of the dredge so that they escaped.

According to Dr. Canu, the characteristics of the genus *Botryllophilus* are shown particularly—First, in the structure and position of the thoracic feet; second, in the almost constant existence of a single ovigerous sac of a *strictly* spherical form sheltered between the fifth feet.

The peculiarity in the fifth thoracic feet in *Botryllophilus* consists mainly in their position on the last thoracic segment. Instead of occupying a position more or less on the ventral aspect of the segment, as is usual amongst the copepoda, the position of the fifth feet is more or less round towards the dorsal aspect, and as they each consist of a single-jointed, elongated, and somewhat curved spine-like appendage which projects more or less out from the body, they impart to the copepod a rather curious appearance.

After the above note on *Botryllophilus* had been sent to the printer, several specimens of the copepod were obtained *in situ* in a specimen of *Botryllus* sp. collected at Station X. in the Moray Firth on the 16th of June 1898. Some of the specimens carried a globular ovisac on the dorsal aspect between the fifth feet as stated above, but the ovisacs appear to be easily detached; they were of a pale cream colour, due, probably, to the long immersion in spirit of the *Botryllus*.

Canuella perplexa, T. and A. Scott.

1893. *Canuella perplexa*, T. and A. Scott, Ann. Scot. Nat Hist., vol. ii., p. 92, Pl. II., figs. 1–3.

This copepod was obtained in shore gatherings of Crustacea collected at Cumbrae, Firth of Clyde, between tide-marks May 6th, 1899, and in shore pools at Inverkip on the 13th of the same month. The species appeared to be moderately rare at both places. *Canuella* is widely distributed, but is apparently more frequent amongst weed and where the bottom is of a sandy nature.

Ectinosoma gracile, T. and A. Scott.

1896. *Ectinosoma gracile*, T. and A. Scott, Trans. Linn. Soc. (2. z.) vol. vi., p. 429. Pls. XXXVI., XXXVII., XXXVIII.

A few specimens of this very small species were obtained in shore pools at Inverkip, Firth of Clyde, May 13th, 1899. *Ectinosoma gracile* has already been recorded from near Sanda Island, Firth of Clyde; it appears to be widely distributed, but being very small is easily overlooked.

Tachidius brevicornis (Müller).

1776. *Cyclops brevicornis*, Müller, Zool. Dan., Prodr. (2414).

Though *Tachidius brevicornis* appears to be generally distributed, there are apparently few or no records of it as a member of the Clyde fauna. Being a brackish-water species, it need not be sought for except where such conditions exist, and as there are few shores around the British Islands where brackish-water pools are not to be found, the distribution of the species is correspondingly extensive. There are two species of *Tachidius* recorded for Britain, but the one referred to is readily distinguished by the structure of the fifth thoracic feet, which are of the form of two comparatively broadly, roundish plates, the free margins of which are fringed with setæ. The species was found in shore pools at Cumbrae in May 1899. The second species *Tachidius littoralis*, Poppe, has already been recorded from Hunterston, Firth of Clyde.*

Amymone nigrans, T. and A. Scott.

1894. *Amymone nigrans*, T. and A. Scott, Ann. and Mag. Nat. Hist. (6), vol. xiii., Pl. VIII., figs. 1–7.

This curious copepod is rather less than half a millimetre across the

* *Proc. Nat. Hist. Soc. Glasg.*, vol. V. (N.S.), p. 351, 1900.

longest diameter, and is of a blackish colour; it is therefore easily overlooked. The species have only hitherto been observed in Cromarty Firth, where it is not uncommon. I now record it for Loch Fyne, some specimens having been obtained in a gathering of dredged material collected near Otter Spit, Upper Loch Fyne, on January 12th, 1899.

Jonesiella fusiformis (Brady and Robertson).

1875. *Zosime fusiformis*, B. and R., Brit. Assoc. Rep., p. 196.

This seems to be the most frequent representative of the genus in Loch Fyne; in the Firth of Forth it is *Jonesiella spinulosa.*, B. and R., that is the more frequent species. *Jonesiella fusiformis* occurs not rarely in material dredged on Tarbert Bank, Lower Loch Fyne; it is collected here in almost every dredging that is taken. The latest record I have of *Jonesiella fusiformis* from this locality is December 12th, 1899.

Stenhelia blanchardi, T. and A. Scott.

1895. *Stenhelia blanchardi*, T. and A. Scott, Ann. and Mag. Nat. Hist. (6), vol. xvi. p. 353, Pl. XV., figs. 1–10.

This distinct but apparently rare copepod was dredged off Arisaig, Argyleshire, in 1892, though not described till 1895. No further specimens were observed till the present year (1899), when the species was again found; this time in some material dredged in the "Fluke Hole," off St. Monans, Firth of Forth, in 1896, and the examination of which had been delayed for want of time. This species is readily distinguished from others of the same genus by the form of the secondary branches of the fifth pair of thoracic feet, which terminate in hook-like processes. The occurrence of the species in the Firth of Forth tends to indicate that, though it seems to be rare, it may at the same time be widely distributed.

Canthocamptus inconspicuus, sp. n. (Pl. XIV., figs. 1–8.)

Description of the Female.—In general appearance this species is somewhat similar to *Canthocamptus parvus*, T. and A. Scott. The length of the specimen figured measures from the forehead to the end of the caudal furca 54mm. (about $\frac{1}{46}$ of an inch). The antennules, as in the species mentioned, are short and six-jointed; the third joint is longer than any of the others, being about equal to the entire length of the two joints preceding as well as of the two that follow it. The formula shows approximately the proportional lengths of the different joints—

Proportional lengths of the joints,	13 · 12 · 32 · 15 · 13 · 20
Number of the joints,	1 · 2 · 3 · 4 · 5 · 6.

The antennæ are each furnished with a one-jointed secondary branch. The mandibles are small, and they are provided with a small one-branched but moderately elongated palp (fig. 3). The first pair of thoracic feet have both branches three-jointed; the inner branches are considerably longer than the outer, and the first joint exceeds in length that of the second and third combined, as shown in the figure (fig. 5). The inner branches of the second, third, and fourth pairs, which are shorter than the outer branches, are only two-jointed, but the outer branches are three-jointed, moderately elongated, and sparingly setiferous (fig. 6). The fifth pair are small and foliaceous; the basal joint is broadly sub-triangular, while the secondary one is small and ovate; both are provided with a few setæ, arranged as shown in the drawing (fig. 7). The caudal segments are slender and about as long as the anal segment (fig. 8). The female carries one ovisac.

Remarks.—This copepod has a superficial resemblance to a small form, with six-jointed antennules, described by T. and A. Scott under the name of (?) *Canthocamptus parvus.** Like that form, the copepod now described has the antennules six-jointed, and the inner branches of the second, third, and fourth pairs of thoracic feet two-jointed, but the proportional lengths of the joints of the antennules are different, and the caudal furca, which in *Canthocamptus parvus* are very short, are in the species now described as long as the anal segment. No males have been observed.

Habitat.—Moray Firth; obtained amongst some dredged material.

Mesochra spinicauda, T. and A. Scott.

1895. *Mesochra spinicauda*, T. and A. Scott, Ann. and Mag. Nat. Hist. (6), vol. xv., p. 52, Pl. V., figs. 12–25.

This was one of several curious species that were found in shore pools at Musselburgh, Firth of Forth; the pools occurred between tide marks, but nearer low water, and were surrounded on all sides by beds of mussels. I am now able to record the occurrence of the species in shore pools near Millport, Cumbrae; it was obtained in some gatherings collected by hand-net on May 6th, 1899.

Tetragoniceps (?) *malleolata*, Brady. (Pl. XIV., figs. 9–17.)

1880. *Tetragoniceps malleolata*, Brady, Mon. Brit. Copep., vol. ii., p. 66, Pl. LXXVIII., figs. 1–11.

In Part III. of the *Tenth Annual Report of the Fishery Board for Scotland* (1892), p. 252,† I recorded the occurrence of a species of copepod which had been obtained in the Firth of Forth off St. Monans, and which I had ascribed to *Tetragoniceps malleolata*, G. S. Brady. I then pointed out, however, that this copepod, while agreeing in most points with the genus and species named, differed in so far as it possessed nine-jointed instead of eight-jointed antennules, and in the fifth pair of thoracic feet being two-jointed instead of being composed of only one joint. At the time the record was published, I was quite aware that the second of these two differences was, in view of the definition of the genus, a somewhat important one, but considered that, as the copepod referred to resembled the species named in almost all the other details of structure, it was better to ascribe it to that species rather than to institute a new genus or species for its reception.

During the past year I have obtained, in some dredged material from the Firth of Forth collected in 1896, but only recently examined, a few more specimens of the copepod referred to above, as well as of another and somewhat closely allied form that appears to be undescribed.

When the supposed *Tetragoniceps malleolata* was recorded in the *Tenth Annual Report* no detailed description of the form was given; a reference to the two principal points of difference was considered to be at that time all that was necessary for the identification of the form. The occurrence, however, of the closely allied and apparently undescribed species which I have alluded to makes it desirable that a description of both forms should now be given, so that the differences that have been observed between them may be more clearly indicated.

It may be considered doubtful whether the two forms to be described should be retained in the genus *Tetragoniceps*, but for the present, at

* *Ann. and Mag. Nat. Hist.* (6), vol. xviii., p. 6, Pl. II., figs. 14–22 (1896).

† Additions to the Fauna of the Firth of Forth, Part IV.

least, I prefer to leave them there. The earlier recorded form will be described first.

Description of (?) *Tetragoniceps malleolata*, Brady.

The body of this copepod is elongated and slender, tapering more or less gradually from the head to the extremity of the abdomen; the rostrum is short, the cephalic and thoracic appendages are moderately elongate, and the entire length of the specimen figured is ·89mm. (the $\frac{1}{28}$ of an inch). The antennules in the female are nine-jointed; the first joint is long, and the inner distal angle is produced into a stout and somewhat triangular tooth-like process; the next three joints are considerably shorter than the first; the last joint is about as long as the fourth, but the four joints that precede the last one are small; a moderately long sensory filament or *asthetask* springs from the end of the fourth joint as shown in the drawing (fig. 10). The antennæ, mandibles, and maxillæ are nearly similar to those in *Tetragoniceps bradyi*.* The posterior foot-jaws are three-jointed, but the end joint is very small; there are two terminal setæ—one moderately elongate, the other smaller and slightly plumose. The outer branches of the first to the fourth pairs of thoracic feet are all three-jointed, but all the inner branches are two-jointed. In the first pair, which are comparatively slender, the inner branches are elongate, the first joint being rather longer than the entire length of the outer branches; the second joint, which is scarcely half the length of the first, carries two stout terminal setæ—the inner one being the longer; there is also a small seta on the lower half of the inner edge of the first joint. The inner branches of the second, third, and fourth pairs are considerably shorter than the outer branches; those of the second and third pairs extend slightly beyond the second joint of the outer branches; but in the fourth pair the inner scarcely reach the middle of the second joint of the outer branches, and this difference is owing, in part at least, to the outer branches of the fourth pair being proportionally more elongated than the outer branches of the two preceding pairs. The fifth pair of feet are two-jointed; the basal joint is foliaceous and somewhat triangular in outline; it is provided with three small setæ on the lower half of the inner margin, and with a small apical seta. The second joint is elongated and narrow, and it tapers gradually till it becomes somewhat attenuated at the extremity; this joint is provided with a few small setæ on the outer edge and one on the inner, and also with a slender terminal hair. The caudal segments are slender, and about as long as the last abdominal segment.

The female carries one ovisac, which contains a few moderately large ova arranged in a single series.

The male differs little from the female, except that the antennules are hinged, and otherwise modified for grasping; the fifth pair of feet are also less fully developed; the basal joint is sub-quadrate, and the inner portion slightly produced distally and furnished with two moderately stout, spiniform apical setæ; the secondary joint is sub-cylindrical, and is armed with a moderately stout and elongated spine near the distal end of the inner margin. The first abdominal segment in the male bears slightly produced lateral appendages provided with three moderately long setæ; these appendages are situated immediately posterior to the fifth thoracic feet.

Habitat.—Firth of Forth, off St. Monans; rather rare.

Tetragoniceps brevicauda, sp. n. (Pl. XIV., figs. 18–22.)

As already stated, this copepod does not differ very greatly from

* *Vide* Part III. *Tenth Ann. Report Fishery Board for Scotl.*, p. 253, Pl. IX. (1892).

(?) *Tetragoniceps malleolata*, but, for the reasons stated below, I prefer to describe it under a distinct name rather than as a "variety" of the species referred to; for, after all, the question as to whether a thing is a "species" or a "variety" is very much a matter of opinion.

Description of the Female.—In general appearance the female of *Tetragoniceps brevicauda* is not unlike the form just described, but is somewhat smaller. The specimen figured (fig. 18) is only about ·7mm. (about $\frac{1}{36}$ of an inch in length). The antennules have a structure somewhat similar to those of (?) *Tetragoniceps malleolata*, and there is the same hook-like process on the distal extremity of the first joint; the proportional lengths of the nine joints are, however, somewhat different. The mouth-organs and swimming-feet resemble those of the species named, except that the first feet appear to be rather more slender, and the fifth pair are proportionally somewhat smaller, but the secondary joint of the fifth pair is distinctly more elongated proportionally than that of the fifth pair in (?) *Tetragoniceps malleolata* (fig. 21). The caudal segments (fig. 22) are distinctly shorter than those of the species named, and they are also proportionally stouter; the size and form of the caudal furca of the species under description are so different from those of the closely allied form previously recorded as not only to have suggested the name that has been applied to it, but were the chief characters that first attracted my attention when examining the material in which it was found.

No males of this form and only very few females have been observed.

Habitat.—Firth of Forth, off St. Monans.

Pseudolaophonte spinosa (I. C. Thompson).

1893. *Laophonte spinosa*, I. C. Thompson, Revised Report on the Copepoda of Liverpool Bay, Trans. L'pool. Biol. Soc., vol. vii., p. 24, Pl. XXX., figs. 1–13.

1896. *Pseudolaophonte aculeata*, A. Scott, Report Lancashire Sea Fisheries (1895), p. 11, Pl. III., figs. 7–23.

This rare copepod species occurred in a gathering of dredged material collected near Otter Spit, Loch Fyne; a male and a female specimen were obtained. The antennules in this species are each furnished with a prominent and strong spine on the lower (exterior) aspect of the second joint; both the male and female possess these spines; the female antennules appear to be only four-jointed. The species has a close general resemblence to *Laophonte*, so much so that, like Mr. I. C. Thompson, I was at first inclined to regard it as a member of that genus, but a close examination of the thoracic appendages, and especially of the swimming-feet, bring to light structural differences that must exclude it from the genus *Laophonte*. The principal differences, as pointed out by Mr. A. Scott, are observed in the structure of the second and third pairs of swimming-feet. In the second pair each foot consists of a single one-jointed branch, and in the third pair, though each foot is two-branched, both branches are only two-jointed. This interesting and somewhat anomalous copepod has not before been recorded from the Clyde district.

Leptopsyllus minor, T. and A. Scott.

1895. *Leptopsyllus minor*, T. and A. Scott, Ann. Scot. Nat. Hist. (Jan. 1895), p. 31, Pl. II., figs. 15–22.

This species belongs to a group of peculiarly slender copepods, the first of which was added to the British fauna in 1894.* Hitherto all the

* Part III. of *Twelfth Ann. Report of the Fish. Board for Scot.* (1894), p. 254.

described species have been found either in shore pools or in comparatively shallow water. The females do not appear to be very prolific; they usually carry but one ovisac, which contains only a few—frequently not more than three or four—ova. It is interesting to note, however, that though the creatures are small their ova are comparatively of large size.

Leptopsyllus minor, which has not before been recorded from the Clyde, was obtained in shore pools near Millport, Cumbrae, and also at Inverkip during the past summer.

Leptopsyllus herdmani, I. C. Thompson and A. Scott.

1900. *Leptopsyllus herdmani*, I. C. Thomp. and A. Scott, Trans. L'pool Biol. Soc., vol. xiv., p. 141, Pl. VIII.

A few specimens of this minute species were obtained, along with the species just recorded, in the shore pools at Millport, Cumbrae, in May 1899. One of the principal differences between this species and *Leptopsyllus minor* is in the comparative lengths of the inner and outer branches of the first thoracic feet; in the present form the inner branches are considerably longer than the outer ones, while in *Leptopsyllus minor* the inner are scarcely longer than the outer branches. There are some other differences, but they are less obvious than the one referred to.

Nannopus palustris, G. S. Brady.

1878. *Nannopus palustris*, G. S. Brady, Mon. Brit. Copep., vol. ii., p. 101, Pl. LXXVII., figs. 18–20.

This curious copepod was obtained in brackish-water pools at Inverkip, Firth of Clyde, on May 13th, 1899, but it did not appear to be very common. It has a superficial resemblance to *Platychelipus*, and may have sometimes been passed over as such. There are very few Clyde records for *Nannopus*.

Cylindropsyllus minor, T. Scott. (Pl. XIV., figs. 23–32.)

1892. *Cylindropsyllus minor*, T. Scott, Part III., *Tenth Ann. Report Fish. Board for Scot.*, p. 260, Pl. XI., figs. 17–24.

The copepod described under this name was discovered in 1891 off St. Monans, Firth of Forth. At that time no males had been observed, and therefore, though the characters of the female, so far as they could be made out, agreed very well with the definition of the genus *Cylindropsyllus*, there was still the probability that the species might not after all be a true member of that genus.

During the past year the examination of a gathering of entomostraca collected in the same locality where the species was first discovered yielded several additional specimens to those already observed, and this time both males and females were obtained. The occurrence of these specimens has enabled me not only to revise the previous description of the female, but to add to that a description also of the male, and to show conclusively that the species is a true *Cylindropsyllus*.

Description of the Female.—Body cylindrical (fig. 23); length of the specimen figured, 97mm. (fully $\frac{1}{2.5}$ of an inch). The antennules, which are comparatively short, are nine-jointed; the second joint is considerably longer than any of the other joints. Their proportional lengths are shown approximately by the formula :—

Proportional lengths of the joints,	$7 \cdot 43 \cdot 14 \cdot 10 \cdot 10 \cdot 8 \cdot 16$
Numbers of the joints,	$1 \cdot 2 \cdot 3 \cdot 4 \cdot 5 \cdot 6 \cdot 7$

The antennæ closely resemble those of *Cylindropsyllus lævis*, but the end joints are proportionally rather longer; the secondary branches (protopodites) appear also to be slightly more elongated. The mandible-palp, which is moderately slender, is of greater length than the same appendage in *Cylindropsyllus lævis*, and is composed of two joints, but the last joint is small (fig. 24). The maxillæ appear to be similar to those of the species named. The anterior foot-jaws (first maxillipedes) are small and apparently one-jointed; the single joint is somewhat dilated, and bears two elongate processes at the distal end of the inner margin; the terminal claw is also moderately large and stout (fig. 25). The posterior foot-jaws (second maxillipedes) are slender and two-jointed, and armed with a moderately long, slender, almost setiform, terminal claw (fig. 26). All the thoracic feet are as previously described. The caudal segments are nearly as long as the anal segment, and they are each furnished with a broad, sabre-like terminal spine nearly of the same length as the furcal segment, and each spine bears a secondary setiform process on the outer margin (fig. 29). The segments are also provided with one or two minute hairs.

Description of the Male.—The antennules of the male are modified for grasping. The cephalo-thoracic and other appendages are similar to those of the female, except in the following particulars:—(1) The outer branches of the second pair of thoracic feet, which are moderately stout and elongate, are each armed with a stout elongated falciform terminal process, bent inwardly at nearly right angles to the joint from which it springs. These processes are somewhat similar to those on the outer branches of the second feet of the male of *Cylindropsyllus lævis*, but the apex is somewhat differently modified, as shown by the drawing (fig. 30). (2) The short inner branches of the third pair differ from those of the female in having the first joint produced interiorly into a stout tapering spine, which is slightly sinuate, and extends beyond the end of the second joint; the second joint is dilated—both margins being convex (fig. 31). (3) The caudal segments are provided with terminal spines that are stout and tapering (fig. 32). It may also be noted that the exterior spine with which each of the fifth feet in the female is armed is wanting in those of the male.

Cylindropsyllus minor, though apparently not very common, is a widely distributed species; it has been obtained not only off St. Monans, Firth of Forth, but also at Ballantrae Bank, Firth of Clyde. I have not, however, observed male specimens other than those referred to in the preceding description, which are from the Forth estuary; probably the males are scarcer than the other sex.

Huntemannia jadensis, S. A. Poppe.

1884. *Huntemannia jadensis*, S. A. Poppe, Abhandl. d. Nat. Ver. Bremen, Bd. IX., p. 59.

In previous years I have recorded this curious species from the head of West Loch Tarbert (Cantyre), and from the Cromarty Firth, which hitherto appeared to be the only two Scottish localities where this copepod was known to occur. I have now to report two additional stations for *Huntemannia*, both of which are in the Clyde district. It was taken with the hand-net in shore-pools a little below high-water mark at the south-west corner of the Greater Cumbrae on May 6th, 1899, and in shore-pools at Inverkip on the 13th of the same month. At the latter place I obtained for the first time one or two females with ovisacs. I find that the females of this species carry two ovisacs of average size, which contain a considerable number of small ova. What

we know of the distribution of this species tends to show that it is more or less restricted to brackish water.

Ilyopsyllus coriaceus, Brady and Robertson.

1873. *Ilyopsyllus coriaceus*, B. & R., Ann. and Mag. Nat. Hist. (4), vol. xii., p. 132, Pl. IX., figs. 1–5.

I have to record the occurrence of this small but interesting species from the Cromarty Firth. It was obtained in a brackish-water pool at the mouth of the River Alness in the summer of 1893, and only one specimen was observed. It was not recorded at that time, as it was expected that other specimens might be found, when a description with drawings of the species would have been prepared. No more specimens have, however, been discovered, and I now therefore place on record the solitary specimen obtained, which appears to be a female.

Quite recently the Rev. A. M. Norman very kindly presented me with a few specimens of this species collected by himself at Birterbuy Bay, Ireland, in 1874. These at first sight looked as if they belonged to another species, for, instead of the broad spathulate furcal setæ referred to in Prof. G. S. Brady's description and figures, the principal furcal setæ were long and slender; but this, it was afterwards found, was merely a sexual difference, the specimens I had received from Dr. Norman being males, whereas the Cromarty Firth specimen, like that described by Prof. Brady, was a female. Moreover, it was observed that a form of *Ilyopsyllus*, which, in my report on some Entomostraca from the Gulf of Guinea, I had described under the name of *Ilyopsyllus affinis*, resembled so closely these Birterbuy males that it is probably only a southern form of *Ilyopsyllus coriaceus*. The Gulf of Guinea specimens were obtained in a shore-gathering collected at the Island of Sao Thome. These Copepods are strongly gibbous on the dorsal aspect, and the peculiar spathulate furcal setæ of the female of *Ilyopsyllus coriaceus* serve to distinguish it readily from its congeners.

Scutellidium tisboides, Claus.

1866. *Scutellidium tisboides*, Claus, Die Copep.-Fauna v. Nizza, p. 21, t. iv., figs. 8–15.

This somewhat rare copepod has been obtained at various times in shore-pools between tide-marks at Bay of Nigg, Aberdeen. The species does not appear to be very rare in some of the gatherings obtained here. On the other hand, I have as yet failed to obtain it in the Firth of Clyde, and neither Mr. Robertson nor Prof. Brady appear to have observed it there; neither do I remember of its having been observed by us in the Firth of Forth—probably its distribution is local rather than rare. The colour of the Bay of Nigg specimens was generally not very pronounced; some were colourless, but usually they were tinged more or less with a light brownish pigment.

Clausia cluthæ, T. and A. Scott.

1896. *Clausia cluthæ*, T. and A. Scott, Ann. and Mag. Nat. Hist. (6), vol. xviii., p. 1., Pl. I., figs. 1–12.

Several specimens of this curious copepod have been obtained in dredged material from Tarbert Bank, Lower Loch Fyne. Though this is apparently the first time that *Clausia cluthæ* has been recorded from Loch Fyne, it is not the first time for the Clyde generally; the specimens from which the species was described were discovered in Ayr Bay in

1896. In this species the fifth thoracic feet project outward from each side of the body, and are more or less conspicuous. The genus *Clausia* was established by Claperède in 1863. Boeck, not knowing this, established a genus of free-swimming Copepods under a similar name in 1864, but in 1872 Boeck changed his "*Clausia*" to "*Pseudocalanus*."

Corycæus anglicus, Lubbock. (Pl. XIII., figs. 1–14.)

1857. *Corycæus anglicus*, Lubbock, Ann. and Mag. Nat. Hist. (2), vol. XX., Pl. XI., figs. 14–17.

This pretty species was added to the British fauna by Sir John Lubbock in 1857 from specimens which had been obtained at Weymouth. For a considerable number of years afterwards our knowledge of the British distribution of the species was almost entirely limited to the information contained in the description which Sir John had published.

In 1880 Prof. G. S. Brady, by the publication of the third volume of his monograph of British Copepoda, was able to considerably extend the known distribution of our *Corycæus*. But though our knowledge of its British distribution continued to increase from year to year, there has apparently been no record of it from the Scottish seas till 1896, when a report of its occurrence in the Firth of Forth was published in Part III. of the *Fourteenth Annual Report of the Fishery Board for Scotland.* So far as I know, no further captures of *Corycæus* have been made in Scottish waters till the past summer, when it was taken in the Firth of Clyde. It occurred in a surface tow-net gathering collected in the vicinity of Ailsa Craig on the 29th of May.

The presence of *Corycæus anglicus* in our Scottish estuaries may be owing to changes in the trend of oceanic currents induced by the prevalence of certain winds,* or it may be that the methods of research being now more perfect than formerly, the presence of such organisms is more readily detected. Several specimens of *Corycæus* were obtained in the Clyde gathering collected on the 29th of May, and some of the colouring of the species still remained when they first came under my observation. Both males and females were obtained.

The female represented by the drawing on Plate XIII. measured slightly over one millimetre in length, while the length of the male, which is represented by one or two detailed figures on the same plate, was slightly less than that of the female. The female antennules are short and six-jointed. The proportional lengths of the joints are shown approximately by the formula:—

$$\text{Proportional lengths of the joints, Number of the joints,} \quad \frac{8 \cdot 8 \cdot 8 \cdot 10 \cdot 7 \cdot 5}{1 \cdot 2 \cdot 3 \cdot 4 \cdot 5 \cdot 6}$$

The antennæ (fig. 3) are stout; each is armed with a moderately strong and slightly-hooked terminal claw; an elongated spine springs from the inner distal angle of the first joint, while one or two smaller spines occur on the other joints. In the male the terminal claws of the antennæ are long and sickle-shaped (fig. 12). The biting part of the mandible is armed with a few moderately long teeth, and one or two spine-like lateral appendages. The palp is very small, and composed of a single one-jointed branch (fig. 4). The maxillæ are simple, one-jointed and moderately stout, and armed with a few short, stout, apical, and sub-apical spines (fig. 5). The anterior foot-jaws (fig. 6) are short and very stout, their structure is somewhat rudimentary, and their armature consists of several

* My son, Mr. Andrew Scott, in a letter to me on July 28th, incidentally mentioned that Mr. I. C. Thompson "had been getting *Corycæus anglicus* in abundance off Port Erin, Isle of Man, a week or two ago." That would be nearly about the time it was observed in the Clyde.

apical and sub-apical setæ. The posterior foot-jaws of the female (fig. 7) have moderately short and slender terminal claws, but those of the male (fig. 13) are armed with terminal claws of considerable length. The first three pairs of swimming-feet have both branches three-jointed. The inner branches, which are considerably shorter than the outer, are provided with a number of setæ on the inner margin and apex, but have apparently no terminal spines; the outer branches are also furnished with several setæ on the inner edge. Moreover, the first and second joints bear a short but moderately stout spine on the exterior distal angle, while the third joint carries two marginal and two apical spines, the inner one of the two apical spines being longer and stouter than the other (figs. 8 and 9). In the fourth pair (fig. 10) the inner branches are reduced to a single minute joint; the outer branches are also comparatively small, and they want, to a large extent, the spiniform armature of the outer branches of the preceding pairs. The fifth pair are small, and each consists of a single one-jointed branch, which is furnished with two apical setæ (fig. 11).

In the female the lateral processes of the fourth body segment extend backward to about the middle of the penultimate segment of the abdomen. This abdominal segment appears to be larger in the male than in the female, as shown by the figure (fig. 14). The caudal segments in both male and female are moderately elongated, being about one and a half times the length of the anal segment.

This species when living is one of the more brilliantly coloured of the British Copepods, but spirit extracts the colour very quickly.

Monstrilla (?) *danæ*, Claparède. (Pl. XIII., figs. 15–20.)

1863. *Monstrilla danæ*, Clap., Beobacht. üb. Anat. u. Enwickl.-wirbellos Thiere an der Küste v. Normandie angestellt., p. 95.

Representatives of this curious genus of copepods have, as in previous years, been occasionally observed in tow-net gatherings of entomostraca from the Clyde. Two or three species of the Monstrillidæ have been recorded from North Britain, but the only one that has hitherto been observed in the Clyde estuary is the species now referred to, and which I have for the present ascribed to Claparède's *Monstrilla danæ*. The genus *Monstrilla* was added to the British fauna in 1857 by Sir John Lubbock, when he described the *Monstrilla anglica*. For nearly thirty years afterwards little or nothing further appears to have been known concerning these organisms, so far at least as regards their distribution in the British seas, and in view of this it is somewhat remarkable that now not a year passes without a lesser or greater number of specimens, representing sometimes two or three different species, being observed.

In 1890 Gilbert C. Bourne published in the *Quarterly Journal of Microscopical Science* a little paper on the genus *Monstrilla*, and gave a short summary of the characters of the different forms. He divided them into two groups, distinguished by the number of furcal hairs. In the one group the number of setæ on each furcal member is said not to exceed three, while in the other there are said to be six setæ on each of the caudal furca. *Monstrilla danæ* was placed by Mr. Bourne in the first of these groups.

The Clyde specimens which I record here, and which I am inclined to ascribe to *Monstrilla danæ*, do not fit in with either of Mr. Bourne's groups as regards the number of furcal hairs. In the more perfect of the specimens there are five hairs on each of the caudal rami, four of which are prominent and one very small; of the four large hairs, three spring

from the end of the furca and one from a notch on the outer margin; the small hair is also marginal.

The male and female have each three abdominal segments. Those of the male are nearly of equal size, but in the female the genital segment is about as long as the combined length of the next two, and it is provided on the ventral aspect with two moderately long setæ. In the specimen figured (fig. 15) several minute ova were observed attached to these genital setæ, as shown in the drawing. The fifth thoracic feet in the female (fig. 18) are sub-cylindrical, and rather longer than broad, and carry two apical setæ.

Monstrilla danæ appears to be more frequent in Upper Loch Fyne than in the seaward part of the Clyde. In a tow-net gathering collected on the 28th November last (1899) near the head of the loch as many as twenty-seven specimens of *Monstrilla* were obtained, apparently all belonging to this species. But a much larger number of specimens was obtained in a gathering collected, also near the head of the loch, in the month of September immediately preceding. This gathering, which was collected with the surface tow-net on the 29th of the month referred to, was a small gathering, and contained a considerable quantity of fibrous matter. It was not examined until the following month of March, when over eighty specimens were obtained! The specimens comprised both males and females, but whether they all belong to the one species I am not yet in a position to say. The fact that such a large number of specimens was found in a single small gathering is of no little interest in its bearing on the distribution of these curious animals.

Pseudanthessius thorellii (Brady and Robertson).

1875. *Lichomolgus thorellii*, B. and R., Brit. Assoc. Report, p. 197.

This species, which is one of the Lichomolgidæ distinguished by the possession of elongated caudal furca, has been obtained in dredged material from various parts of the Clyde area. It is quite easily distinguished from *Lichomolgus forficula*, which also has long furca, not only by the structure of the inner branches of the fourth pair of swimming-feet and the difference in the proportional lengths of the abdominal segments, but also by the difference in *habitat*. *Lichomolgus forficula* lives in the branchial cavity of large Ascidians, while *Pseudanthessius thorellii* appears to live free amongst weed or zoophytes, and perhaps also amongst *Filograna*. I have not on any occasion found it naturally inside an Ascidian, and neither does Professor Brady in his description of the species refer to it as a commensal.

Hermanella arenicola (G. S. Brady).

1872. *Boeckia arenicola*, G. S. Brady, Nat. Hist. Trans., Northumberland and Durham, vol. iv., p. 430.

A specimen of this fine species was obtained in a gathering of entomostraca from Loch Gilp (near Ardrishaig, Loch Fyne), which is a new Clyde Station for this species. The vicinity of Otter Spit is the only other locality within the Clyde area that I know of where *Hermanella arenicola* has been obtained.

Asterocheres (?) *echinicola* (Norman). (Pl. XIV., figs. 33–36.)

An *Asterocheres* is obtained in the water passages of a sponge (*Suberites* sp.), common both in the Clyde and Loch Fyne, which is closely allied to *Asterocheres echinicola* (Norman), and which may probably be only a

variety of that species. It differs from the typical *Asterocheres echinicola* in having the caudal segments rather shorter than the anal segment, while in typical specimens these are slightly longer than that segment. The general outline of the cephalothorax, and especially the outline of the posterior margin of the third segment, seem also to be slightly different, as shown by the drawing (fig. 33). Moreover, the outer lobe of the maxillæ is also apparently somewhat shorter than that of the same appendages in *Asterocheres echinicola*, but whether such differences are constant seems somewhat doubtful.

A species of *Asterocheres* described by Dr. Giesbrecht, of Naples, under the name of *Asterocheres suberites*, seems to have a *habitat* similar to this Loch Fyne form, and it also agrees with the same form in having the caudal segments shorter than the anal segment; indeed the difference in the length of the caudal segments appears to constitute one of the principal points of distinction between *Asterocheres echinicola* (Norman) and *Asterocheres suberites* (Giesbrecht). Notwithstanding the points of agreement observed between this Clyde copepod and Giesbrecht's *A. suberites*, I prefer for the present at least to ascribe it to the *A. echinicola*, Norman. It may also be noted that *Asterocheres boecki* (G. S. Brady) was occasionally obtained in the water-passages of *Suberites* in company with the *A.* (?) *echinicola*.

Rhynchomyzon purpurocinctum (T. Scott).

1893. *Cyclopicera purpurocinctum*, T. Scott, *Eleventh Ann. Report Fish. Board of Scot.* (III.), p. 209, Pl. III., figs. 29-40.

This species, which has already been recorded from one or two places on the East Coast of Scotland, has only recently, and for the first time, been observed in the Clyde district. It occurred in the washings of dredged materials (weed, gravel, sand, etc.) collected in the vicinity of Otter Spit, Upper Loch Fyne, on January 12th, 1899, at a depth of about 8 to 15 fathoms. The occurrence of the species here would seem to indicate that though it may be, and probably is, a scarce one, it may be more or less generally distributed around our shores. The species is readily distinguished not only by its general form, but by the fact that it is adorned by a dark purple-coloured band extending across the thorax, and it is worth noting in regard to this band that a lengthened immersion in methylated spirits appears to have had little effect on it. Usually the spirit extracts the colouring matter very quickly from these microforms, but it would appear that in this case the purple pigment is of a more permanent character than that generally observed in the colours of copepoda.

Artotrogus orbicularis, Boeck.

1859. *Artotrogus orbicularis*, Boeck, Forh. Vid.-Selsk., Christiania, p. 2. Pl. I.

One specimen, about one millimetre in length and 0·78 millimetre in breadth, was obtained amongst some washings of material dredged on Tarbert Bank, Loch Fyne, on the 28th October last (1899). This is the second specimen of this rare species from the same locality.* I. C. Thompson has recorded this species from the Liverpool Bay district,† but Tarbert Bank, Lower Loch Fyne, is the only Scottish locality I know of where *Artotrogus orbicularis* has been obtained.

* *Sixteenth Ann. Report Fish. Board of Scot.* (III.), p. 272, Pl. XIV., figs. 12-21 (1898).

† *Trans. Lit. and Phil. Soc., Liverpool*, vol. viii., p. 37.

Parartotrogus richardi, T. and A. Scott.

1893. *Parartotrogus richardi*, T. and A. Scott, Ann. and Mag. Nat. Hist. (6), vol. xl., p. 210, Pl. VII.

This curious little species has not before been observed in the Clyde area. It is a form that is readily missed, and may therefore be more widely distributed than at present it appears to be. In Scotland it has only hitherto been observed in the Firth of Forth, but it has also been found in the vicinity of Naples by Dr. W. Giesbrecht.

Amphipoda.

A few of the amphipods observed in the tow-net and other gatherings sent from the Fishery steamer "Garland" may now be noticed. Only the rarer forms are recorded here.

Hyperiidæ.

Hyperia galba, *Parathemisto* (?) *oblivia*, and *Hyperoche tauriformis* have been occasionally observed in the tow-net gatherings sent from the Clyde and Loch Fyne. These may still be reckoned as comparatively rare amphipods in the Clyde area. Their scarcity here is in somewhat marked contrast to the frequency of the species on the East Coast.

Pontoporeiidæ.

Urothoë marina has been obtained at Tarbert Bank, Loch Fyne, while *Argissa hamatipes* (Norman) has been observed in tow-net gatherings collected both in Loch Fyne and in the seaward portion of the Clyde estuary. *Argissa* is sometimes frequent in under surface tow-net gatherings from the Clyde. The somewhat remarkable difference in the dorsal aspect of the urosome in the male and female is an interesting feature of this species. *Argissa* was also obtained in a tow-net gathering collected in Aberdeen Bay in May 1898.

Amphilochidæ.

A number of species belonging to this group have been observed in the gathering of tow-netted and dredged material sent from the "Garland" during the past year. One of these appears to be identical with a form discovered a few years ago in the Moray Firth. This form was described in the "Annals and Magazine of Natural History" * under the name of (?) *Cyproidia brevirostris*, T. and A. Scott; it is a very small amphipod, scarcely reaching to two millimetres in length; the Clyde specimens, which are of a somewhat chocolate-brown colour are easily overlooked. *Cyproidia brevirostris* comes very near *Cyproidia danmoniensis*, Stebbing. *Stegoplax longirostris*, G. O. Sars, is also another closely allied form. A few specimens of *Cyproidia brevirostris* were obtained in some dredged material from Tarbert Bank, Loch Fyne—a rocky bank which rises to within 15 or 17 fathoms of the surface, while all around the water is deep. This amphipod has not before been recorded from the Clyde area.

Epimeridæ.

Epimeria cornigera (Fabricius), var. In Part III. of the *Fifteenth Annual Report of the Fishery Board for Scotland* (1897), p. 169, I recorded from the Clyde a specimen of what appeared to be *Epimeria tuberculata*, G. O. Sars; and since then a few more specimens of the

* Ser. 6, vol. xii., p. 244, Pl. XIII. (1893).

same form have been obtained. They are usually found in bottom tow-net gatherings from the deeper parts of the Clyde. It now appears that these Clyde specimens do not belong to Sars' *Epimeria tuberculata*, but are a deep-sea variety of *Epimeria cornigera*. They seem to form a connecting link between the two species named, and to belong nearly as much to the one as to the other. It is a form which is in some respects as handsome as typical specimens of either species, both in size and coloration.

EUSIRIDÆ.

Specimens of *Eusirus longipes*, Boeck, have been occasionally observed during the year in bottom tow-net gatherings both from the Clyde and Loch Fyne, but few of the specimens appeared to be mature.

GAMMARIDÆ.

Mœra othonis (M.-Edw), *Cheirocrates intermedius*, G. O. Sars, and *Lilljeborgia kinahani* (Spence Bate) have all been obtained in material dredged at Tarbert Bank, Loch Fyne, at a depth of 15 to 17 fathoms. *Megaluropus agilis* was captured in a tow-net gathering from the vicinity of Sanda Island, Clyde, collected September 5th, 1899.

PHOTIDÆ.

Leptochirus pilosus.—A few specimens of this species were recently obtained in material from Tarbert Bank. In most of the Clyde specimens I have seen, some of which were females with ova, the secondary branches of the antennules are only two-jointed, the end joint being quite small. Another species, *Microprotopus maculatus*, Norman, was obtained in a bottom tow-net gathering, recently examined, collected in Aberdeen Bay in May 1898.

PODOCERIDÆ.

Of species belonging to this group the following may be mentioned :—*Ischyrocerus minutus*, which was obtained in the same gathering as that in which the *Microprotopus* referred to above, was observed. *Erichthonius abditus* occurred in a bottom tow-net gathering from 28 fathoms collected in the vicinity of Ailsa Craig, Firth of Clyde, October 10th, 1899.

CAPRELLIDÆ.

Protella phasma (Mont.) is not very rare at Tarbert Bank, Loch Fyne. There are few hauls with the dredge taken here in which it does not occur. *Caprella linearis* (Linn.) was obtained at Inverneil Bay, Loch Fyne, by Mr. F. G. Pearcey in November 1899. Males and females of the same pecies have also been captured by the fishery steamer in the Morays Firth.

Caprella septentrionalis, Kröyer.—One specimen of this somewhat rare species was captured in the Cromarty Firth on June 6th, and another on November 23rd, 1898. I am not aware of any previous record of this species for the East Coast of Scotland.

ISOPODA.

There are few isopods to record. A considerable number of the chelifera have been observed during the year, but most of the species to which they belong have already been recorded. A few, however, require further study.

Several parasitic forms have been observed, among which are the following:—*Phryxus abdominalis*, attached to the under side of the abdomen of *Spirontocaris securifrons*, captured in the shrimp-trawl net of the fishery steamer "Garland" near the seaward limit of the Clyde estuary. *Pseudione affinis*, attached under the carapace of *Pandalus montagui*, also from near the mouth of the Clyde. *Pleurocrypta marginata*, attached under the thoracic shield of *Galathea dispersa*, taken at Station XIII. (Upper Loch Fyne), October 10th, 1899. *Aspidophryxus peltatus*, attached to the back of *Erythrops serrata* and *Erythrops elegans*,* from deep water to the east of Arran, Firth of Clyde, July 18th, also obtained at Station XIII. (Upper Loch Fyne) on 29th December 1899.

Cumacea.

Several species of cumacea have been obtained in recent gatherings of tow-net and dredged material, most of which have already been recorded, but the following may be mentioned:—*Campylaspis rubicunda* has again occurred in bottom-gatherings from the deep water of Upper Loch Fyne. *Cumella pygmæa* was obtained in dredged material from Tarbert Bank, Lower Loch Fyne. *Nannastacus unguiculatus* and species of *Diastylis* have also been observed in Clyde tow-net gatherings. *Cuma edwardsii* was obtained in a bottom tow-net gathering collected in Aberdeen Bay; while *Cumopsis edwardsii* (sp. Bate) (=*C. goodsiri*, Van Ben.†) was taken between tide-marks on the shore near Millport, Cumbrae, Firth of Clyde, on May 6th, 1899, where it had previously been found by Dohrn thirty years before.‡ *Cumopsis longipes* (Dohrn) (=*C. lævis*, G. O. S.) has also been recorded from the Clyde. These two species are somewhat like each other in size and general appearance, but in *Cumopsis edwardsii* the cephalo-thoracic shield is adorned on both sides with two oblique and arcuate lateral folds; while in that of the other species the lateral folds are altogether wanting. Moreover, the natatory branches of the first pair of feet in *Cumopsis edwardsii* are composed of ten joints, but of only eight joints in *Cumopsis longipes*.§ *Cumopsis edwardsii* did not appear to be very rare between tide-marks at Cumbrae. A considerable number of adult and young specimens were included in the gathering I collected at Cumbrae in May last.

Schizopoda.

Thysanoessa neglecta (Krŏyer).—I have again to report the occurrence of this Euphausid from the Firth of Clyde. In my Notes published in the *Seventeenth Annual Report*, *Thysanoessa neglecta* is recorded for the Clyde for apparently the first time. The specimens referred to in that Note had been obtained in a bottom tow-net gathering from Station X., near the seaward limit of the estuary, collected on January 16th, 1899, at a depth of 26 fathoms. The specimens referred to on the present occasion were obtained in two separate bottom tow-net gatherings from Station XII., between Arran and Turnberry Head. These gatherings were collected, the one on the 18th and the other on the 24th of July 1899. In the first one five specimens were obtained, but only two were observed in the other. This species, though apparently rare in the Clyde district, is one of the more common schizopods on the East Coast. As pointed out by Dr. Norman in his useful "Synopsis of the British

* A specimen of the curious *Aspidæcia normani* occurred also on the back of a specimen of *Erythrops elegans*, from the same part of the Clyde estuary. (See also record of *Aspidæcia* in Part III. of the *Sixteenth Ann. Report of the Fishery Board for Scotland.*

† Cf. Scott, *S. F. B. Rept.*, 1888, p. 253.

‡ Cf. *Jen. Zeitschr.*, vol. v., 1869; *Unters. üb. Bau u. Entw. d. Arthropoden*, 1870, p. 28.

§ *Vide* Prof. G. O. Sars' description of the two species in his work *Middelhavets Cumaceer.*

Schizopoda," this *Thysanoessa* is readily distinguished from its near ally by having a spine over the base of the telson.

Mysidopsis gibbosa and *Mysidopsis angusta* have both been obtained in tow-net gatherings forwarded from the Clyde, as also have *Leptomysis gracilis* and *Praunus inermis*. *Neomysis vulgaris*, a Mysid which appears to be rare in the Clyde district, formed part of the contents of the stomach of a fifteen-spined stickleback (*Gasterosteus spinachia*) captured near the head of Loch Fyne on the 16th of April last (1899). The same Mysid has been obtained in the Dhu Loch, near Inveraray.

Siriella armata (M. Edw.) and *Siriella clausii*, G. O. Sars, were obtained in a gathering of crustacea from Loch Gilp by Mr. F. G. Pearcey, the naturalist on board the "Garland." The first—*Siriella armata*—has been occasionally captured in the Clyde during recent years, but the second—*Siriella clausii*—has, so far as I remember, only once before been recorded from the Clyde district, viz., in 1886, when one or two specimens were taken in East Loch Tarbert. The specimen now recorded from Loch Gilp is a male, apparently full-grown. It was captured in three to five fathoms on 31st October 1899.

Siriella armata, besides having a strongly produced rostrum, has usually some of the cephalic and caudal appendages ornamented with chocolate-coloured blotches. The body, especially on the ventral aspect, is also occasionally coloured. *Siriella clausii* appears to be colourless.

Erythrops serrata, G. O. Sars, and *Erythrops elegans*, G. O. Sars, have both been obtained in tow-net gatherings of the "Garland" forwarded from the Clyde. *Erythrops serrata*, which appears to be of more frequent occurrence than the other, has been observed for the most part in gatherings from the seaward portion of the estuary; while *Erythrops elegans* is taken occasionally in Loch Fyne, as well as further to seaward. Both are sometimes infested with parasites.

Anchialus agilis, G. O. Sars.—Two specimens of this rare Schizopod were obtained in a tow-net gathering collected at Station VI., Firth of Clyde (a little to the east and north of Sanda Island). They occurred in a bottom tow-net gathering from a depth of 20 to 27 fathoms collected on December 15th, 1898. Sars obtained the *Anchialus* in the Bay of Naples at a depth of six to eight fathoms, and he also obtained one near Messina at a depth of 20 fathoms.

Anchialus is one of the many interesting species which Dr. A. M. Norman has added to the British fauna. The single female specimen recorded by him was obtained at Plymouth in 1890. There does not appear to be any previous record of *Anchialus* from the Clyde estuary. Dr. Norman has seen my specimens.

Decapoda.

Xantho hydrophilus (Herbst).—A single specimen of this species—a male—was captured with the shrimp-trawl of the "Garland" at the mouth of the Clyde, at a depth of 60 fathoms, on June 15th, 1899, and forwarded by Mr. Pearcey to the Laboratory, Bay of Nigg, and is now in the collection there. One of the characters that seems to distinguish this form from *Xantho incisus*, Leach, is that the claws have the movable finger grooved on the upper aspect; the grooves extend nearly the whole length of the fingers. All the joints of the feet in *Xantho hydrophilus* are also ciliated on the upper edge, while in *Xantho incisus* the third only is ciliated.

Corystes cassivelaunus (Pennant).—A small male specimen of this species was captured in the same gathering as the last, and is now in the

collection at Bay of Nigg. It measures about 20mm. from the extremity of the rostrum to the base of the dorsal shield.

Jaxea nocturna, Nardo.

In my paper on Clyde tow-net and other gatherings published in Part III. of the *Seventeenth Annual Report* (1899) I reported the occurrence of an interesting lucifer-like crustacean in the Firth of Clyde. I stated further that this crustacean had been identified with a form, also from the Clyde, which had been described in the Proceedings of the Royal Society, Edinburgh, vol. xv., p. 420, figs. 1 and 2 in the text (1889), by the late George Brook under the name of *Trachelifer*. In some additional remarks which immediately follow what had been stated in regard to Brook's description of *Trachelifer*, it is clearly shown that this "*Trachelifer*" was really the young of *Calliaxis adriatica*, Heller. Nothing further transpired concerning these Clyde organisms till last summer, when I received from Mr. F. G. Pearcey, the naturalist on board the "Garland," a number of fragments of a small *Nephrops*-like crustacean which he had found in the stomachs of some gurnards captured in the vicinity of Ailsa Craig, near the mouth of the Clyde estuary. It was at once evident that these fragments did not belong to *Nephrops norvegicus*, though in some respects they had a more or less close resemblance to that crustacean. The species, however, could not be made out for a considerable time. At first it was thought that the fragments might represent one or other of the described species of *Nephropsis*, but with none of these would they fit in satisfactorily. Failing, for various reasons, to arrive at a satisfactory solution of the difficulty, I applied to the Rev. T. R. R. Stebbing, who has not unfrequently proved in such matters to be a "friend indeed;" and he, after some investigation, found that the fragments which had given us so much trouble belonged to a species which Nardo in 1847 had described under the name of *Jaxea nocturna*. He, moreover, pointed out (as he does also in his *History of Crustacea*, p. 187) that *Jaxea nocturna* is identical with *Calliaxis adriatica*, Heller, described in 1856; and as *Trachelifer* is the young of *Calliaxis*, so also, as a matter of course, is it the young of *Jaxea*. The position of the species may therefore be stated thus:—

Jaxea nocturna, Nardo (1847).
= 1856. *Calliaxis adriatica*, Heller.
= 1889. *Trachelifer*, sp. (jun.), Brook.

Another point of interest that may now be considered is the *habitat* of *Jaxea*. Can we claim it as a member of the Clyde fauna? In regard to this point I am inclined, after a careful consideration of all the circumstances, to consider that we may fairly make this claim. We find these juvenile forms occurring at more or less frequent intervals in various parts of the Clyde area,* and occasionally in considerable numbers, two or three different stages of development being represented, and latterly, as pointed out, fragments of several adult specimens have been found in the stomachs of gurnards caught in the vicinity of Ailsa Craig. From the state of preservation in which these fragments were found it is scarcely likely that the time that had elapsed between the capture by the gurnards of the specimens to which the fragments belonged and the capture of the gurnards themselves in the "Garland's" trawl-net could have been very great. All this seems to indicate that the adult *Jaxea* are not very far off from the places where these larvæ and fragments were obtained. It

* *Trachelifer* was obtained in a bottom tow-net gathering collected at Station V. (Whiting Bay)—a station well within the limits of the Clyde estuary—on October 11th, 1899.

might be thought that if *Jaxea* were present in the Clyde, specimens occasionally ought to be taken in the trawl or dredge, yet none have ever been observed. This, however, does not militate against the supposition that this crustacean occurs within the Clyde estuary, for its *habitat* may be about rocky ground, where neither trawl nor dredge could be used, but which would offer no obstruction to gurnards in their search for food. Moreover, it was shown in my paper in Part III. of the *Seventeenth Annual Report* (1899) that at Naples, though the larval forms of *Calliaxis* (*Jaxea*) are met with amongst the surface fauna, the adult has only been found once in 25 years. But whatever be the opinion concerning the *habitat* of this apparently rare species—that is, "rare" as regards its adult form—the fact that fragments of adults were found in the stomachs of gurnards caught in the vicinity of Ailsa Craig is in itself of much interest to students of the British crustacea. The fragments referred to above are now in the Laboratory at Bay of Nigg.

After the preceding notes had been sent to the printer, Mr. Pearcey kindly forwarded the posterior portion of another specimen of *Jaxea*, which he had obtained in the stomach of a witch sole (*Pleuronectes cynoglossus, L.*) captured at Station VIII., Firth of Clyde, on the 20th of November last (1899). Station VIII. is about five miles west by south of Ailsa Craig. (This specimen is in our collection at Bay of Nigg with the others previously referred to.)

EXPLANATION OF THE PLATES.

PLATE XIII.

Corycæus anglicus, Lubbock.

Fig. 1. Female, dorsal view . . . . . × 70.
Fig. 2. Antennule . . . . . × 190.
Fig. 3. Antenna . . . . . × 190.
Fig. 4. Mandible . . . . . × 380.
Fig. 5. Maxilla . . . . . × 380.
Fig. 6. Anterior foot-jaw . . . . . × 380.
Fig. 7. Posterior foot-jaw . . . . . × 190.
Fig. 8. Foot of first pair of swimming-feet . . . . × 190.
Fig. 9. Foot of third pair ,, ,, ... × 190.
Fig. 10. Foot of fourth pair ,, ,, ... × 190.
Fig. 11. Foot of fifth pair . . . . . × 760.
Fig. 12. Antenna, male . . . . . × 190.
Fig. 13. Posterior foot-jaw, male . . . . . × 190.
Fig. 14. Abdomen and caudal stylets, male . . . . × 160.

Monstrilla (?) *danæ*, Claparède.

Fig. 15. Female, dorsal view . . . . . × 20.
Fig. 16. Antennule, male . . . . . × 40.
Fig. 17. Foot of first pair of swimming-feet, female . . . × 80.
Fig. 18. Fifth thoracic feet, female . . . . . × 40.
Fig. 19. Last thoracic segment, abdomen and caudal stylets, male . × 80.
Fig. 20. Fifth thoracic feet, male . . . . . × 40.

Enterocola (?) *fulgens*, Van Beneden.

Fig. 21. Female, dorsal view . . . . . × 40.
Fig. 22. Antennule . . . . . × 160.
Fig. 23. Antenna . . . . . × 160.
Fig. 24. Maxilla . . . . . × 190.
Fig. 25. Posterior foot-jaw . . . . . × 253.
Fig. 26. Foot of first pair of swimming-feet . . . . × 126.
Fig. 27. Foot of second pair ,, ,, ... × 126.

Gunenotophorus (?) *globularis*, Costa.

Fig. 28. Female, lateral view . . . . . × 17.
Fig. 29. Antennule . . . . . × 190.
Fig. 30. Antenna . . . . . × 19.
Fig. 31. Mandible and palp . . . . . × 84.
Fig. 32. Posterior foot-jaw . . . . . × 190.
Fig. 33. Foot of fourth pair of swimming-feet . . . . × 80.
Fig. 34. Last segments of the abdomen and caudal stylets . . × 40.

PLATE XIV.

Canthocamptus inconspicuus, sp. n.

Fig. 1. Female, side view . . . . . × 80.
Fig. 2. Antennule . . . . . × 380.
Fig. 3. Mandible . . . . . × 380.
Fig. 4. Posterior foot-jaw . . . . . × 380.
Fig. 5. Foot of first pair of swimming-feet . . . . × 380.
Fig. 6. Foot of fourth pair ,, ,, ... × 380.
Fig. 7. Foot of fifth pair . . . . . × 380.
Fig. 8. Last segments of the abdomen and caudal stylets . . × 80.

Tetragoniceps (?) *malleolata*, Brady.

Fig. 9. Female, side view . . . . . × 80.
Fig. 10. Antennule . . . . . × 253.
Fig. 11. Posterior foot-jaw . . . . . × 380.
Fig. 12. Foot of first pair of swimming-feet . . . . × 253.
Fig. 13. Foot of third pair ,, ,, ... × 150.
Fig. 14. Foot of fourth pair ,, ,, ... × 150.
Fig. 15. Foot of fifth pair . . . . . × 166.
Fig. 16. Last abdominal segment and caudal stylets . . . × 126.
Fig. 17. Foot of fifth pair and appendage of first abdominal segment . × 253.

Tetragoniceps brevicauda, sp. n.

Fig. 18. Female, side view . . . . . × 80.
Fig. 19. Antennule . . . . . × 253.
Fig. 20. Foot of first pair of swimming-feet . . . . × 380.
Fig. 21. Foot of fifth pair . . . . . × 380.
Fig. 22. Last abdominal segment and caudal stylets . . . × 126.

Cylindropsyllus minor, T. Scott.

Fig. 23. Female, back view . . . . . × 80.
Fig. 24. Mandible and palp . . . . . × 380.
Fig. 25. Anterior foot-jaw . . . . . × 380.
Fig. 26. Posterior foot-jaw . . . . . × 380.
Fig. 27. Foot of first pair of swimming-feet . . . . × 253.
Fig. 28. Foot of fifth pair ,, ... × 380.
Fig. 29. Last abdominal segment and caudal stylets . . . × 190.
Fig. 30. Foot of second pair of swimming-feet, male . . . × 380.
Fig. 31. Foot of third pair of swimming-feet, male . . . × 380.
Fig. 32. Last abdominal segment and caudal stylets, male . . × 190.

Asterocheres echinicola, Norman.

Fig 33. Female, dorsal view . . . . . × 80.
Fig. 34. Antenna . . . . . × 190.
Fig. 35. Mandible and palp . . . . . × 190.
Fig. 36. Maxilla . . . . . × 126.

Gunenotophorus (?) *globularis*, Costa.

Fig. 37. Anterior foot-jaw . . . . . × 126.
Fig. 38. Foot of first pair of swimming-feet . . . . × 95.

GLASGOW:

PRINTED FOR HER MAJESTY'S STATIONERY OFFICE
BY JAS. HEDDERWICK & SONS.

EIGHTEENTH

ANNUAL REPORT

OF THE

FISHERY BOARD FOR SCOTLAND

Being for the Year 1898.

IN THREE PARTS.

Part I.—GENERAL REPORT.
Part II.—REPORT ON SALMON FISHERIES.
Part III.—SCIENTIFIC INVESTIGATIONS.

PART III.—SCIENTIFIC INVESTIGATIONS

Presented to Parliament by Command of Her Majesty.

1899.

NINETEENTH

ANNUAL REPORT

OF THE

FISHERY BOARD FOR SCOTLAND

Being for the Year 1900.

IN THREE PARTS.

Part I.—GENERAL REPORT.
Part II.—REPORT ON SALMON FISHERIES.
Part III.—SCIENTIFIC INVESTIGATIONS.

PART III.—SCIENTIFIC INVESTIGATIONS.

Presented to both Houses of Parliament by Command of Her Majesty.

1901.

SALE OF GOVERNMENT PUBLICATIONS.

The undermentioned Firms have been appointed sole Agents for the sale of Government publications, including Parliamentary Reports and Papers, Acts of Parliament, Patent Office Publications, &c., &c., and all such documents for purchases in which these names are given, or through retail booksellers, who are entitled to a discount of 2d. per cent. from the published prices.

IN ENGLAND:—

For all publications excepting Ordnance and Geological Maps, the Hydrographical Works of the Admiralty, and Patent Office Publications.—Messrs. Eyre & Spottiswoode, East Harding Street, E.C.

For Hydrographical Works of the Admiralty.—Mr. J. D. Potter, 145 Minories.

Patent Office Publications are sold at the Patent Office.

For all Publications excepting the Hydrographical Works of the Admiralty, Patent Office Publications, and Ordnance and Geological Maps:—

IN SCOTLAND:—Messrs. Oliver & Boyd, Edinburgh.

IN IRELAND:—Mr. E. Ponsonby, 116 Grafton Street, Dublin.

ORDNANCE SURVEY MAPS OF GREAT BRITAIN AND IRELAND.—The Agents for the sale of these Maps in most of the chief towns. Copies may be ordered at many Head Post Offices and through any Bookseller, or from the Director-General Ordnance Survey, Southampton; or, in the case of Ireland, the Officer in Charge Ordnance Survey, Dublin.

GEOLOGICAL SURVEY PUBLICATIONS OF GREAT BRITAIN AND IRELAND.—The Agents for the sale of Ordnance Survey Maps are also, as a rule, Agents for the sale of Geological Survey Publications.

The following is a list of some of the more important Parliamentary and Departmental Publications recently issued:—

Parliamentary.

Statutes.

Public General, Session 1899, Vols. 2, and 1900, Vols. 1 and 2. With Index, Tables of Cases

Second Revised Edition. A.D. 1235-1713 to A.D. 1872-1884. XVI Vols.

Revised Edition. Titles showing subsequent Repeals, effected by Acts of Session 61 Vict. 1898.

Statutes in Force. Index to. 1898 Edition. To end of 62 & 63 Vict. 3 Vols.

The Statutory Rules and Orders revised. Statutory Rules and Orders, other than those of a Local, Personal, or Temporary Character, issued prior to 1890, and now in force. Vol. I. to VIII.

Statutory Rules and Orders other than those of a Local, Personal, or Temporary Character. With a List of the more important Statutory Orders of a Local Character arranged in classes and an Index. Revised Edition. Issued in the years 1890, 1893, 1897, 1898, 1899, 1900, 1901, and 1902.

Statutory Rules and Orders in force on 31st December 1903. Index to.

Statutory Rules and Orders, 1903. Registered under the Rules Publication Act, in course of issue.

Acts of Parliament, Public Local, and Private, Session 1901. In course of issue.

[Cd. 916.] Local Government, Scotland. Special Reports. Vol. IV. Canada—Newfoundland, &c.

[Cd. 917.] Do. do. Vol. V. Cape Colony, &c.

[Cd. 918.] Do. do. Vol. VI. Preparatory Schools.

Boys' Day Schools in England, Secondary Education.

[Cd. 919.] Technical and Commercial Education in Four Provinces, Poland, Galicia, and Podolia, by James Baker, F.C.P.S.

[Cd. 927, 928.] Food Investigation, Examination, 1902. Report of Committee (2 Vols.).

[Cd. 931.] Mines Act (Inspectors) and Regulations for establishing Pits, 1902.

[Cd. 929.] Local Taxation. Rating Commission. Final Report as to England and Wales.

[Cd. 966.] Factories and Workshops. Report of Chief Inspector. Year 1902.

[Cd. 967.] Agricultural Tenancies (Fixity, Disp. and other Matters). First Report of Royal Commissioners. Vol. I.

Mines. Reports of H.M. Inspectors for 1902, with Summaries of the Returns made under the provisions of the Coal Mines Regulation Acts, 1887; Metalliferous Mines Regulation Acts, 1872 & 1875; Coal Mines (Check Weighing) Act, 1903; Tinworks Act, 1893. (Complete.)

Mines in the United Kingdom and the Isle of Man. List of, for 1902.

Mines Abandoned. List of the Plans of, deposited in Mines Department, 1902.

NINETEENTH

ANNUAL REPORT

OF THE

FISHERY BOARD FOR SCOTLAND,

Being for the Year 1900.

IN THREE PARTS.

PART I.—GENERAL REPORT.
PART II.—REPORT ON SALMON FISHERIES.
PART III.—SCIENTIFIC INVESTIGATIONS.

PART III.—SCIENTIFIC INVESTIGATIONS.

Presented to both Houses of Parliament by Command of His Majesty.

GLASGOW:
PRINTED FOR HIS MAJESTY'S STATIONERY OFFICE
BY JAMES HEDDERWICK & SONS,
AT "THE CITIZEN" PRESS, ST. VINCENT PLACE.

And to be purchased, either directly or through any bookseller, from
OLIVER & BOYD, EDINBURGH; or
EYRE & SPOTTISWOODE, EAST HARDING STREET, FLEET STREET, E.C.,
and 32 ABINGDON STREET, WESTMINSTER, S.W.; or
E. PONSONBY, 116 GRAFTON STREET, DUBLIN.

1901.

[Cd. 726.]—*Price* 4*s.* 9*d.*

CONTENTS.

PAGE.

GENERAL STATEMENT 7
The Influence of Trawling 8
Investigations made on board Steam Trawlers . . . 13
The Hatching and Rearing of Food Fishes 14
The Larval Stages of Decapod Crustacea—The Shrimp . . 15
The Parasites of Fishes 15
The Rate of Growth of Fishes 15
The Invertebrate Fauna 16
Seine-Net Fishing for Herrings 16

APPENDICES.

SCIENTIFIC REPORTS.

I. Report on the Trawling Experiments of the "Garland," and on the Fishery Statistics relating thereto . . . 17
Introductory 17
The Moray Firth 18
Table A.—Showing Summary of Fish taken by the "Garland" in Trawling Operations in 1900 24
Table B.—Analysis of the "Garland's" Statistics relating to the relative Abundance of Fish 27
Table C.—Record of Observations made on Board the "Garland" during 1900 28
A. Fish caught 28
B. Physical Observations 43
Table D.—Showing the Quantities of Fish caught by Line within the Moray Firth (inside a Line between Duncansby Head and Rattray Point), and the Number of Shots of the Boats by which the Fish were caught 50
Table E.—Total Quantities of Fish caught by Line within the Moray Firth (inside a Line between Duncansby Head and Rattray Point), and the Number of Shots of the Boats by which the Fish were caught . . 57
II. Investigations made on Board Steam Trawlers. By T. Wemyss Fulton, M.D., F.R.S.E., Scientific Superintendent . 58
III. On the Larval Stages of Decapod Crustacea—The Shrimp (*Crangon vulgaris, Fabr.*). By H. Chas. Williamson M.A., B.Sc., Marine Laboratory, Bay of Nigg, Aberdeen. (Plates I.-VI.) 92

PAGE

Introduction 92
The Movements of the Larva 93
The Moulting of the Larva 94
The Larval Stages 94
Development of the Appendages :— 96
Antennule 96
Antenna 97
Mandible 100
First Maxilla 100
Second Maxilla 101
First Maxillipede 102
Second Maxillipede 103
Third Maxillipede 104
Telson 106
Pereipods 108
Pleopods 112
The Eyes 113
The Branchiæ 113
The Zoëa 114
Literature 115
Explanation of Plates 116

IV.—Notes on some Parasites of Fishes. By Thomas Scott, F.L.S. (Plates VII.-VIII.) 120

General Remarks 120
Part I.—Copepoda Parasita 121
Ergasilidæ 121
Caligidæ 124
Dichelestidæ 126
Lernæidæ 127
Chondracanthidæ 128
Lernæopodidæ 130
Incerta Sedis 136
Part II.—Hirudinea and Trematoda 137
Hirudinea 137
Ichthyobdellidæ 137
Pontobdellinæ 139
Trematoda 141
Tristomatidæ 142
Polystomatidæ 145
Description of Plates 151-153

V.—On the Rate of Growth of the Cod, Haddock, Whiting, and Norway Pout. By T. Wemyss Fulton, M.D., F.R.S.E., Scientific Superintendent. (Plates IX.-XVI.) . . 154

Introduction 154
The Norway Pout 155
Deep-Water Hauls 155
Hauls off Aberdeenshire 160

PAGE

Hauls in Moray Firth 161
Hauls in Firth of Clyde 161
Summary 164
The Whiting 166
Hauls in Aberdeen Bay 166
Hauls in Deep Water 175
Hauls in Moray Firth 178
Summary 185
The Haddock 190
Hauls in Aberdeen Bay 190
Hauls in Moray Firth 199
Hauls in Deep Water 203
Summary 211
The Cod 214
Hauls in Aberdeen Bay 214
Hauls in Moray Firth 218
Hauls in Deep Water 222
Summary 227

VI.—Report on the Hatching Work at the Marine Hatchery, Bay of Nigg, Aberdeen, during the Spring Season 1900. By Harald C. Dannevig. 229

VII.—Notes on Gatherings of Crustacea, collected for the most part by the Fishery Steamer "Garland" and the steam trawler "St. Andrew" of Aberdeen, and examined during the year 1900. By Thomas Scott, F.L.S., Mem. Soc. Zool. de France. (Plates XVII. and XVIII.) . . 235

Introductory Remarks 235
Copepoda 237
Ostracoda 256
Amphipoda 258
Isopoda 269
Sympoda (Cumacea) 273
Schizopoda 276
Macrura 278
Brachyura 279
Explanation of the Plates 280

VIII.—Ichthyological Notes. By T. Wemyss Fulton, M.D., F.R.S.E. Scientific Superintendent 282

NINETEENTH ANNUAL REPORT

TO THE RIGHT HONOURABLE

LORD BALFOUR OF BURLEIGH,

His Majesty's Secretary for Scotland.

OFFICE OF THE FISHERY BOARD
FOR SCOTLAND,
EDINBURGH, 1*st May* 1901.

MY LORD,

In continuation of our Nineteenth Annual Report, we have the honour to submit—

PART III.—SCIENTIFIC INVESTIGATIONS.

GENERAL STATEMENT.

This part of the Nineteenth Annual Report contains an account of the principal scientific investigations conducted by the Board during 1900, in connection with the sea fisheries of Scotland, so far as they have been completed. The scientific researches have been carried on at the Marine Laboratory which was recently erected at the Bay of Nigg, Aberdeen, and also by means of the *Garland*, the small steam yacht which the Board possesses for this work, as well as on steam trawlers fishing from the port of Aberdeen.

It has been explained in several previous Reports that the investigations and trawling experiments are much hampered and restricted owing to the small size and inefficiency of the *Garland*, and this disability to perform the duties for which she was intended increases each year. The vessel is only 84½ feet in length between perpendiculars, is of 36·4 tons register, and is more than twenty years old. In consequence of her unseaworthiness and the necessity for frequent repairs she is compelled to lie in harbour idle during the greater part of the year. Last year, out of about 303 ordinary

working days, she was engaged in scientific work on 112 days, and lay in port for 166 days, the other 25 days being spent in steaming from one place to another. She was laid up for repairs to the boiler, engines, or other parts on seven occasions, which occupied 72 working days, the detention in connection with the annual overhaul extending from 12th July to 6th September, and the cost being close upon £300. Bad weather and other causes kept the vessel in port for other 94 working days, chiefly during winter and spring.

Under these circumstances it is not surprising that the investigations at sea were much interrupted and curtailed, and that it was found impossible with this vessel to follow up the life-history and movements of the principal food-fishes from the inshore to the offshore waters, or to conduct observations on the great fishing grounds whence the greater part of the fish supply is obtained. The trawling experiments carried on in the areas from which trawlers are excluded are also prejudicially affected; and the Board desire again to express the hope that they may be provided with a properly-equipped steamer adequate for the work, as recommended by the Select Committees of the House of Commons in 1893 and 1900.

In this connection it may be stated that several other European countries have recently acquired, or are acquiring, sea-going steamers for scientific fishery researches. The Norwegian Government had one built last year, which has already made investigations of value in the sea between Norway and Iceland and along the Norwegian coast; the Danish Government has proposed to the Diet the expenditure of £10,000 for building a steamer for similar researches, and the German Government is understood to be spending from £15,000 to £20,000 on another steamer of the same kind.

The Technical Education Committee of the County Council of Aberdeen have offered to the Board the sum of £200, which has been accepted, for providing tanks at the Marine Laboratory, on condition that facilities are granted there for the instruction of fishermen from the county.

The Influence of Trawling.

The results of the trawling experiments carried on in the Moray Firth during last year, together with the various Tables embodying the observations in detail, are given in a separate Report (p. 17). Most of the stations which are situated inshore were examined on six occasions, and the outer stations were for the most part examined on three occasions. The number of hauls made with the ordinary net was 71, the time actually occupied in the trawling operations being 126 hours. Besides these hauls, 18 were made with the ordinary shrimp-net at some of the stations, and others in shallow water near shore.

The total number of fishes of all kinds caught in the 71 hauls at the various stations during the year was 8881, or an average of 125·1 per haul. The flat-fishes numbered 6612, and comprised the following species in the numbers stated:

Plaice . . .	1,152	Long Rough Dabs .	1,262
Lemon Soles . .	409	Flounders . . .	26
Witches . . .	109	Turbot . . .	3
Common Dabs . .	3,638	Brill	6
Sail Flukes . .	7		

The number of round-fishes caught was considerably less—viz., 2044, belonging to the following species:—

Cod	147	Hake	18
Haddock . . .	784	Pollack . . .	3
Whiting . . .	198	Catfish . . .	14
Ling	4	Gurnard . .	868
Saithe . .	8		

There were also 84 skates and rays, the remainder consisting of the bib, 39; the angler, 38; the dragonet, 39, and a few other inedible forms.

The quantity of fishes procured by the *Garland* is therefore small, and furnishes an inadequate basis for any conclusions as to the effect of the closure of so wide an area as the Moray Firth. The incompetence of the vessel for the work it was intended to perform, from other reasons than its unseaworthiness, has been frequently pointed out in previous Reports, and is shown in a striking manner when the catches of its small trawl are contrasted with those of a large otter-trawl used by ordinary steam-trawlers, which, with the authority of the Board, fished occasionally for scientific purposes in the Moray Firth last year (*see* p. 58). In a single haul made by the steam trawlers, occupying four hours, more plaice, or haddocks, or cod were frequently caught than the *Garland* caught during the year. The total number of plaice taken by the *Garland* in the 71 hauls referred to was 1152; while in seven successive hauls of a trawler, each haul occupying four hours, the number of plaice taken was never less than 1390, and in one case was 2415. The result of two days' work of the trawlers, in October and November respectively, may be given for comparison with the *Garland's* work for the year:—

	Cod.	Haddock.	Whiting.	Plaice.	Lemon Dab.	Common Dab.	Others.	Total.
Star of Hope. Oct. 10, 11.	159	1,607	185	2,197	1,025	2,943	851	9,057
St. Andrew. Nov. 5, 6.	181	560	109	12,911	60	11,064	345	25,230

The average number of fishes taken in each haul of the *Garland's* net was 125·1, flat-fishes giving an average of 93·1, and round-fishes an average of 28·8. The average number of flat-fishes caught per haul of the net at each of the stations was as follows:—

Station.	Plaice.	Lemon Soles.	Witch Soles.	Common Dabs.	L. Rough Dabs.	Flounder.	Turbot.	Brill.	Total.
I.	19·8	0·2	-	8·2	-	-	-	0·2	28·4
II.	4·3	0·3	2·2	17·6	0·2	-	-	-	34·2
III.	16·6	3·5	-	1·5	-	0·2	-	-	21·8
IV.	61·3	-	-	13·6	0·2	1·2	-	0·3	76·6
V.	36·5	0·3	-	43·6	1·0	1·3	-	-	87·8
VI.	45·2	1·8	0·3	34·8	2·3	1·8	0·2	-	86·3
VII.	1·0	6·2	5·2	124·0	40·2	-	-	-	176·6
VIII.	1·4	5·8	3·6	87·4	59·2	-	-	-	162·4
IX.	1·0	4·4	1·8	85·4	69·6	-	-	0·2	166·0
X.	3·0	4·8	2·6	54·6	18·8	-	-	-	84·2
XI.	2·3	11·3	-	79·0	1·0	-	-	-	93·6
XII.	4·0	14·6	-	100·3	1·3	-	0·3	0·6	121·3
XIII.	2·6	12·6	-	43·3	2·3	-	-	-	61·0
XIV.	0·5	40·5	-	32·5	23·5	-	-	-	97·5
XV.	3·0	9·5	-	117·5	19·0	-	0·5	-	150·0
XVI.	1·5	23·5	1·5	79·5	74·0	-	-	-	180·0
Total.	16·0	5·7	1·5	50·5	17·5	0·3	-	-	93·1

When these averages are compared with those of 1898, the last year in which the Moray Firth stations were examined, they appear to indicate for the Firth generally a slight falling-off in the abundance of plaice and a very considerable diminution in the numbers of common dabs, while lemon soles and long rough dabs are indicated in much the same proportion as before. Among round-fishes the decrease indicated was chiefly in gurnards, but also in haddocks. Skates were represented by the same average in the two years. When the six stations within the three-mile limit are compared in the two years a falling-off is also indicated, except in the months of May and June.

As already stated, however, these observations of the *Garland* are insufficient to furnish any indication of the effect of the closure; and, so long as foreign trawlers continue their operations on any large scale within the Moray Firth, it is evident that the experiments to test the closure will be of little value, unless within the three-mile limit.

The statistics collected from the various districts along the shores of the Moray Firth, to show the quantities of the different kinds of fish caught within the closed waters by line-fishermen, also indicate a decline during last year. The quantities and average per shot in each district for the past six years are as follows:—

District	1895.		1896.		1897.		1898.		1899.		1900.	
	Cwts.	Average.	Cwts.	Average.	Cwts.	Average.	Cwts.	Average.	Cwts.	Average.	Cwts.	Average.
Wick . .	23,009	4·03	31,556	5·40	44,258	6·16	31,383	6·49	26,116	5·106	23,927	4·535
Lybster .	3,977	3·77	4,241	2·87	7,118	4·22	4,438	3·26	4,309	1·398	3,468	1·506
Helmsdale .	16,669	4·15	18,360	4·71	17,148	4·93	13,143	3·84	12,752	3·85	10,330	3·606
Cromarty .	19,193	2·93	15,317	2·51	14,736	2·48	12,428	2·065	11,183	1·815	11,070	1·889
Findhorn .	68,761	4·86	63,521	4·46	46,694	2·66	30,770	2·088	31,825	1·957	21,724	2·31
Buckie .	50,489	4·66	57,450	5·05	50,067	4·77	41,102	4·24	34,915	3·357	22,855	3·209
Banff . .	76,491	4·77	66,471	3·82	61,329	3·70	36,057	2·13	26,675	2·406	18,471	1·834
	258,589	4·43	256,916	4·26	241,350	3·83	169,321	3·244	147,775	2·666	111,845	2·600

With the exception of the Wick district, almost all the line-caught fish landed on the shores of the Moray Firth are taken from the closed waters. The gross quantity last year—namely 111,845 cwts.—is the lowest since these statistics began to b collected; and the average per shot is also slightly lower—viz., 2·60 cwts.—as compared with 2·66 in the year before.

The quantity landed in 1900 was 35,930 cwts. less than in the previous year; 57,476 cwts. less than in 1898; 129,505 cwts. less than in 1897; and 146,744 cwts. less than in 1895. During the six years, therefore, a progressive decline has occurred in the quantity of fish taken by line-fishermen from the closed waters, the gross catch last year having been considerably under half of what it was in 1895. The decline in line-fishing was not confined to the Moray Firth, but was shown also on other parts of the coast, the total quantity of line-caught fish landed being almost 182,000 cwts. less than in 1899.

With respect to the various kinds of fish caught by line in the Moray Firth, the quantities and averages per "shot" for each of the past six years are given in the following Table:—

FISH.	1895.		1896.		1897.		1898.		1899.		1900.	
	Cwts.	Average.	Cwts.	Average.	Cwts.	Average.	Cwts.	Average.	Cwts.	Average.	Cwts.	Average.
Cod	47,646	0·81	64,663	1·07	79,781	1·26	56,208	1·07	52,753	0·95	33,572	0·779
Ling	2,937	0·005	3,868	0·062	3,544	0·056	2,567	0·049	2,883	0·052	2,392	0·055
Torsk	24	—	94	—	25	—	43	—	82	—	18	—
Saithe	5,083	0·087	10,636	0·17	11,761	0·18	14,881	0·28	9,383	0·169	9,126	0·212
Haddock	178,370	3·056	156,703	2·6	126,081	2·004	81,098	1·554	68,075	1·229	54,887	1·275
Whiting	5,114	0·087	4,836	0·08	3,319	0·052	1,535	0·029	1,323	0·023	1,736	0·04
Turbot	—	—	15	—	16	—	13	—	60	—	4	—
Halibut	403	0·007	691	0·011	707	0·011	730	0·013	762	0·013	253	0·005
Lemon Sole	—	—	19	—	14	—	1	—	6	—	4	—
"Flounder, Plaice, and Brill"	5,765	0·09	3,402	0·056	3,978	0·063	3,425	0·065	5,005	0·09	4,242	0·098
Conger	777	0·013	823	0·013	1,533	0·024	826	0·015	741	0·013	333	0·007
Skate	3,014	0·051	3,683	0·061	3,999	0·063	3,273	0·062	3,584	0·064	2,509	0·058
Other kinds of White Fish	9,456	0·16	7,483	0·12	6,663	0·105	4,574	0·087	3,116	0·056	2,769	0·064

The quantity of all line-caught fish landed last year from the closed waters showed a decrease, except whitings. The decrease was greatest in cod and haddocks, which form the bulk of the catches. The decrease in flat-fishes was not so marked. The group which is classified in the returns as "flounders, plaice, and brill," but which probably also contains dabs and other kinds of flat-fishes, diminished from 5005 cwts. to 4242 cwts. Halibut declined from 762 to 253 cwts., and lemon soles from 6 cwts. to 4 cwts.

The number of shots of the fishing boats was also much under the last or any previous year. There were 7070 fewer shots of the large boats, and 9236 fewer shots of the small boats—the total decrease being 16,306 shots. The figures for the past seven years are as follows:—

	1894	1895	1896	1897	1898	1899	1900.
Large Boats	7,082	7,710	11,915	14,039	10,330	12,665	5,595
Small Boats	54,866	50,643	48,346	48,836	41,853	42,808	33,572
	61,948	58,353	60,261	62,875	52,183	55,473	39,167

In all districts there was a decrease in the number of shots of the large boats and also of the small boats, except in the case of Wick. The most marked falling-off was in the districts of Findhorn, Buckie, and Banff.

Investigations Made on Board Steam-Trawlers.

The Board having granted authority for the occasional employment of steam-trawlers within the Moray Firth or other parts of the territorial waters of Scotland for scientific purposes, a number of trips were made in the autumn and winter on board the *Star of Hope* and the *St. Andrew*. The investigations were made in the Moray Firth and Aberdeen Bay in October, November, and December, and two trips were made to the deep-water grounds in September and October. Some of the results are given by Dr. T. Wemyss Fulton in the present Report (pp. 58, 282), and Tables are appended showing the numbers of the various kinds of fish which were taken.

With regard to the question as to whether the abundance of the food-fishes has increased or diminished in recent years on the grounds visited, there are, unfortunately, no records existing with which the present ones can be compared. The hauls of the *Garland* in the Moray Firth and Aberdeen Bay were made with a small beam-trawl (25 feet), and are of little or no use for comparison. It may, however, be of much importance at some future time to have records for comparison such as those now published.

In recording the fishes caught, those which were taken to market were distinguished from those which were thrown overboard, whether on account of their small size or inedibility. The information thus bears directly on the question of the alleged wasteful destruction of undersized fishes by the trawl-net. The proportion rejected because of their small size varied with different species and on different grounds, but it was, as a rule, small. On the inshore grounds about eleven per cent. of the codlings, a little over two per cent. of the haddocks, thirty per cent. of the whitings, and fourteen per cent. of the plaice were thrown back into the sea. On the deep-water grounds the proportion rejected was very much less—viz., one and a half per cent. for codlings, one per cent. for haddocks and whitings, while all the plaice were marketable. The only edible fish thrown away in numbers because of its small size was the common dab, of which only 8484 were taken to market of a total of 33,259 caught.

With regard to the influence of the size of mesh in determining the size of the fishes caught in the otter-trawl, experiments were made by enclosing the cod-end of the latter in a bag of fine netting, which retained the small fishes that escaped through the meshes of the trawl, and special cod-ends with meshes of different size were also employed. It was found that very large numbers of quite small fishes escape uninjured through the apertures in the ordinary commercial trawl with 1½ inch mesh, and that the number caught is comparatively a small proportion of those which enter the net. Of 38,243 taken in experiments with the ordinary otter-trawl, 5906 were caught in the latter, while 32,337 escaped from it. Many of these were whitings, but there were also large numbers of herrings (3230) from 2 inches to 8 inches long, as well as dabs, haddocks, and young cod. With a cod-end having 2-inch meshes the proportion that escaped was much greater—viz., 29,346 of 31,620

which entered the net; 57 per cent. of the haddocks passed through the meshes, some of them being over 12 inches in length—89 per cent. of the dabs, and 11 per cent. of the plaice. With a cod-end having 2½-inch meshes only 282 of a total of 9355 fishes which entered the net were caught, and some of the haddocks which escaped were 18 inches long and weighed nearly 2lbs. With regard to plaice, the percentage which escaped was 0·4 with the ordinary mesh in use, 11 per cent. with the 2-inch mesh, and 22 per cent. with the 2½-inch mesh, some of the latter measuring nearly 10 inches long.

The conclusion from the experiments on this point is that it would be impracticable to use an enlarged mesh for promiscuous or mixed fishing, as ordinarily carried on, since large numbers of eminently marketable fishes such as haddock would escape. With regard to plaice, and most flat-fishes, however, the employment of an enlarged mesh would prevent the capture of many undersized individuals, and there is little doubt that if the prevention of the capture of immature plaice were the only consideration, trawlers would find it profitable to employ such nets if they were permitted to fish where plaice are most abundant.

The investigations with the fine net in the deep water to the east of the Shetland Islands have considerably increased our knowledge as to the distribution of certain fishes. They have shown that a small member of the cod tribe, the Norway Pout (*Gadus esmarkii*), hitherto regarded as rare, and not previously recorded from these regions, is in reality one of the most abundant, as many as over 5000 being captured in one haul of an hour and a half. Specimens of another still smaller and rarer species of the cod, the Silvery Pout (*Gadus argenteus*), were also taken. Other species captured were the Hebridal Smelt or Argentine (*Argentina sphyræna*), the Sharp-Tailed Lumpenus (*Lumpenus lampetræformis*), the Poutassou (*Gadus poutassou*), and the Great Argentine or Siil-Smelt (*A. silus*), which has not hitherto been recorded from the British seas.

The Hatching and Rearing of Food-Fishes.

In the previous Annual Report it was stated that the Marine Hatchery had been removed from Dunbar to the Bay of Nigg, Aberdeen, where the first season's operations were carried on last year. The supply of live adult plaice to serve as spawners was secured at the end of the previous year and in January, a steam-trawler being employed for the purpose. At the beginning of February 1419 plaice had been collected in the large tidal pond, and of these 951 survived to form the breeding stock. The first fertilised eggs were obtained from the pond on 10th March, and from that date until 5th May, 43,290,000 eggs were collected, the number of fry successfully hatched from them being 31,305,000, or 72·3 per cent. Owing to a defect in the inflow pipe, by which fresh water from the soil obtained admission, the specific gravity of the sea-water was considerably lowered, and this caused the death-rate among the eggs in the incubators to be higher than usual. At the close of the season the defect was remedied. The fry were

almost all liberated in the upper waters of Loch Fyne, and the details in regard to the work will be found in a report by Mr. H. Dannevig on page 229. Some of the plaice fry were reared in the hatchery through the larval and post-larval stages, and in January last they measured 3¼ inches in length. The number of the fry of food-fishes which have been turned out from the hatchery at Dunbar and the Bay of Nigg now amounts to 167,795,000, of which 150,900,000 were plaice, 5,720,000 lemon soles, 4,010,000 cod, 5,160,000 turbot, and 2,000,000 other species.

The Larval Stages of Decapod Crustacea—The Shrimp.

In the present Report will be found a paper by Mr. H. Ch. Williamson describing the results of his researches on the larval stages of the common shrimp (*Crangon vulgaris*), a crustacean which forms the object of an important fishery along the English coast and in the Solway Firth. Part of the material for the investigation was obtained from tow-net collections and part from eggs which were hatched at the Marine Laboratory, a complete series of the young in their various stages or moults being thus secured for study. A description is given of the distinguishing characters of each of the stages until the parent form is reached, and the development of the various appendages is traced in minute detail, and illustrated by a series of 199 figures.

The Parasites of Fishes.

Mr. Thomas Scott contributes a paper to the present Report embodying the results of his further researches on the parasites of fishes, which have been extended to include not only the crustacea but also the hirudines or leeches, and the trematodes, and likewise certain of the entozoa. Scarcely any part of a fish is free from parasites; they may be found running over the skin or adhering to the lips, tongue, the fins, gills and gill-covers, embedded in the nasal fossæ, or even attached to the eye. In the course of the investigation a very large number of fishes belonging to many species were examined, and obtained from the *Garland* or steam-trawlers.

The number of species of parasites now described by the author is 53, of which 28 are copepods, 9 leeches, and 16 trematodes, two of the last-named being new to science. The descriptions are illustrated by a series of figures.

The Rate of Growth of Fishes.

In this Report is contained a paper by Dr. Fulton dealing with the rate of growth of the cod, the haddock, the whiting, and the Norway pout, the results being founded upon the measurements of over 34,000 fishes, viz., 2493 cod, 9345 haddocks, 3937 Norway pouts, and 18,466 whitings. By the method adopted the various generations are distinguished from one another and their mean-size calculated. It is shown that the average growth of the adolescent whiting is about 4½ inches in a year, and that while a few spawn when one year old, the great majority spawn first in their second

year, and a few probably not until three years of age. The cod grows quicker than the whiting, increasing by over six inches a year, and spawning for the first time when three, but mostly when four years old. The haddock increases annually by nearly five inches, and spawns when two and three years old; and the Norway pout grows about 2¼ inches in the course of a year, and spawns when one and two years of age. The paper is illustrated by nine plates.

The Invertebrate Fauna.

Mr. Thomas Scott furnishes in the present Report an elaborate paper, illustrated by two plates, descriptive of a large number of crustacea, collected for the most part by the *Garland* and by the steam-trawlers which were used for scientific work. Many rare and interesting forms were procured from the deep-water south-east of the Shetlands and Fair Isle, in some cases from the stomachs of haddocks that were feeding upon them. Four of the species are new to science.

Seine-Net Fishing for Herrings.

During the herring season at Ballantrae Banks in the spring of the present year further observations were made with regard to the action of the herring seine. A number of boats were boarded, and on their nets being hauled examined, as well as the catches brought on board. Of 54 nets examined, 13 were found to have brought up small quantities of herring spawn attached to stones and Laminaria; the others showed no trace of spawn. Some of the spawn was brought to the Marine Laboratory, Bay of Nigg, and kept until the young herrings hatched out, showing that these samples had not suffered injury. The whole question is still under consideration and enquiry.

We have the honour to be,

Your Lordship's obedient Servants,

ANGUS SUTHERLAND, *Chairman.*
D. CRAWFORD, *Deputy-Chairman.*
D'ARCY W. THOMPSON.
J. RITCHIE WELCH.
W. R. DUGUID.
L. MILLOY.
D. MEARNS.

WM. C. ROBERTSON, *Secretary.*

SCIENTIFIC REPORTS.

I. REPORT ON THE TRAWLING EXPERIMENTS OF THE "GARLAND," AND ON THE FISHERY STATISTICS RELATING THERETO.

INTRODUCTORY

During last year the trawling investigations of the "Garland" were conducted in the Moray Firth, and a series of special hauls were also made in Aberdeen Bay and the adjoining waters. Most of the Moray Firth stations which are situated inshore were trawled over on six occasions, one of them on five occasions. The outer stations were for the most part examined three times in the course of the year; two of them, however (XIV. and XV.), were examined only twice—in May and in June. The number of hauls of the ordinary beam-trawl net at the stations in the Moray Firth throughout the year was 71, the time occupied in the actual trawling operations being 126 hours. Besides these ordinary hauls, eighteen were made with the small shrimp-net at the trawling stations, and others in the shallow water near the shore. The work of the "Garland" was often interrupted by bad weather, especially during the winter and autumn months, when it lay for considerable periods in harbour, and also by occasion of frequent repairs, the vessel being detained at Leith in connection with the annual overhaul from early in July to the middle of September.

The work at each station consists in—(1) trawling along a selected line for a specified distance, determined usually by cross-bearings, all the fish caught being enumerated, measured, and recorded; (2) observations on the temperature, density, and transparency of the water, on the condition of the weather, &c.: (3) collections of the pelagic organisms floating in the water. The Tables relating to the chief of these investigations will be found appended to this Report.

The fishery statistics which have been collected in the districts of the Moray Firth in connection with the trawling experiments there, and which show the quantities of the various kinds of fish caught by line fishermen within the closed waters in each month of the year, and for the whole year, with the respective averages per "shot" of the lines, are appended to this Report, and are discussed below. These statistics were collected by the Fishery Officers of the various districts, or by their correspondents. The trawling records were made by Mr. F. G. Pearcey, the naturalist on board the "Garland."

The Moray Firth.

The trawling stations in the Moray Firth are situated as follows, the first six being within the three-mile limit and the remaining ten beyond it:—

I. In Burghead Bay, extending in a westerly direction for 7 miles in from 6 to 7 fathoms; bottom sand.

II. Off Nairn, running parallel to the coast for about 8 miles in from 9 to 12 fathoms; bottom chiefly muddy.

III. Cromarty Firth, stretching for 4 miles from near the town of Cromarty westwards in 4 to 7 fathoms; bottom sand.

IV. Dornoch Firth, curving parallel with the shore for a distance of five miles in 7 to 9 fathoms; bottom mud and sand.

V. Dornoch Firth, running for about 8 miles in from 11 to 15 fathoms; bottom sand and mud.

VI. Dornoch Firth, south of Station V., running westerly for 5 miles, in 10 to 15 fathoms; bottom sand.

VII. Three and three-quarter miles off Tarbet Ness, running nearly E. by S. ½ S. for 3½ miles in from 22 to 28 fathoms; bottom sand and mud.

VIII. Twelve miles E.S.E. from Tarbet Ness and nine miles N. ¾ E. of Lossiemouth, running N. by W. for 3½ miles in 28 to 31 fathoms; bottom sand and mud.

IX. Parallel with VIII., and four miles east of it, running for three miles in 28 to 32 fathoms; bottom sand and mud.

X. Three and one-half miles from Lossiemouth, running in 15 to 13 fathoms for 3½ miles from N.W. to S.E.; bottom sand and shells.

XI. On Smith Bank, running for five miles E. by N., from a point 16½ miles E.S.E. ¼ S. of the Ord of Caithness, in 18 to 25 fathoms; bottom sand and shells.

XII. On Smith Bank, at right angles to XI., beginning 10½ miles S.E. by S. of Clyth Ness, and extending S. by E. for 5 miles in from 18 to 21 fathoms; bottom shells and sand.

XIII. Parallel with XII. east of Smith Bank, running S. by E. for 6 miles in 22 to 27 fathoms; bottom sand and shells.

XIV. Off Clyth Ness, beginning 3 miles E. by S. ½ S. and extending for 5 miles S. by E. in 30 fathoms; bottom sand and shells.

XV. Off Caithness, extending for 6 miles S. by E. from a point 10½ miles S.E. by E. of the Ord of Caithness in 23 to 31 fathoms; bottom sand and mud.

XVI. Begins 18½ miles N. of Macduff, extending northwards in 34 to 36 fathoms for 6 miles; bottom sandy.

The total number of fishes of all kinds caught in the 71 hauls at the above stations during 1900 was 8881, or an average of 125·1 per haul. The flat-fishes numbered 6612, and comprised the following species in the numbers stated:—

Plaice	1,152	Long Rough Dabs	1,262
Lemon Soles	409	Flounders	26
Witches	109	Turbot	3
Common Dabs	3,638	Brill	6
Sail Flukes	7		

The number of round-fishes caught was considerably less—viz., 2044, belonging to the following species:—

Cod	147	Hake	18
Haddock	784	Pollack	3
Whiting	198	Catfish	14
Ling	4	Gurnard	868
Saithe	8		

There were also 84 skates and rays, and the remainder consisted of the bib or brassie (*Gadus luscus*) 39, the angler 38, the dragonet 39, and a few other inedile forms.

The quantity of fishes procured by the "Garland" is therefore small, and furnishes a most inadequate basis for any conclusions as to the effect of the closure of so wide an area as the Moray Firth. The incompetence of the vessel for the work it was intended to perform, from other reasons than its unseaworthiness, has been frequently pointed out in previous reports.

It is shown in a striking manner when the catches of its small trawl are contrasted with those of a large otter-trawl used by ordinary steam trawlers, which, with the authority of the Board, fished occasionally for scientific purposes in the Moray Firth last year (*see* p.58). In a single haul made by the steam trawlers, occupying four hours, more plaice, or haddocks, or cod were frequently caught than the "Garland" caught during the year. The total number of plaice taken by the "Garland" in the 71 hauls referred to was 1152, while in seven successive hauls of a trawler, each haul occupying four hours, the number of plaice taken was never less than 1390, and in one case was 2415. The result of two days' work of the trawlers, in October and November respectively, may be given for comparison with the "Garland's" work for the year :—

	Cod.	Haddock.	Whiting.	Plaice.	Lemon Dab.	Common Dab.	Others.	Total.
Star of Hope.								
Oct. 10, 11.	159	1,697	185	2,197	1,025	2,943	851	9,057
St. Andrew.								
Nov. 5, 6.	181	560	109	12,911	60	11,064	5	25,230

The average number of fishes taken in each haul of the "Garland's" net was 125·1, flat-fishes giving an average of 93·1 and round-fishes an average of 28·8. The average number of flat-fishes caught per haul of the net at each of the stations was as follows :—

Station.	Plaice.	Lemon Soles.	Witch Soles.	Common Dabs.	L. Rough Dabs.	Flounder.	Turbot.	Brill.	Total.
I.	19·8	0·2	–	8·2	–	–	–	0·2	28·4
II.	4·3	0·8	2·2	17·6	9·2	–	–	–	34·2
III.	16·6	3·5	–	1·5	–	0·2	–	–	21·8
IV.	61·3	–	–	13·6	0·2	1·2	–	0·3	76·6
V.	36·5	0·3	–	48·6	1·0	1·3	–	–	87·8
VI.	45·2	1·8	0·3	34·8	2·3	1·8	0·2	–	86·3
VII.	1·0	6·2	5·2	124·0	40·2	–	–	–	176·6
VIII.	1·4	5·8	8·6	87·4	59·2	–	–	–	162·4
IX.	1·0	4·4	1·3	88·4	69·6	–	–	0·2	116·0
X.	3·0	4·8	2·6	54·6	18·8	–	–	–	84·2
XI.	2·3	11·3	–	79·0	1·0	–	–	–	93·6
XII.	4·0	14·6	–	100·3	1·3	–	0·3	0·6	121·3
XIII.	2·6	12·6	–	43·3	2·3	–	–	–	61·0
XIV.	0·5	40·5	–	32·5	23·5	–	–	–	97·5
XV.	3·0	9·5	–	117·5	19·0	–	0·5	–	150·0
XVI.	1·5	23·5	1·5	79·5	74·0	–	–	–	180·0
Total,	16·0	5·7	1·5	50·5	17·5	0·3	–	–	93·1

When these averages are compared with those of 1898, the last year in which the Moray Firth stations were examined, they appear to indicate for the Firth generally a slight falling off in the abundance of plaice and a very considerable diminution in the numbers of common dabs, while lemon soles and long rough dabs are indicated in much the same proportion as before. Among round-fishes the decrease indicated was chiefly in gurnards, but also in haddocks. Skates were represented by the same average in the two years. When the six stations within the three-mile limit are compared in the two years a falling off is also shown, except in the months of May and June.

As already stated, however, these observations of the "Garland" are insufficient to indicate any conclusion as to the effect of the closure, more especially when it is considered that many foreign trawlers have habitually frequented the Firth during recent years. If the foreign trawlers take anything like the quantity of fish that was taken by the two trawlers above referred to, it is evident that the "Garland's" experiments to test the value of closing the waters must, under the circumstances, be of very little value.

In addition to the trawling experiments of the "Garland," statistics have been collected showing the quantities of fish taken by line-fishermen within the limits of the Moray Firth. The total quantities and the average catch per "shot" of the line in each of the districts for the past six years are as follows:—

District.	1895.		1896.		1897.		1898.		1899.		1900.	
	Cwts.	Average.	Cwts.	Average.	Cwts.	Average.	Cwts.	Average.	Cwts.	Average.	Cwts.	Average.
Wick,	23,009	4·03	31,556	5·40	44,258	6·16	31,383	6·49	26,116	5·106	23,927	4·535
Lybster,	3,977	3·77	4,241	2·87	7,118	4·22	4,438	3·26	4,309	1·398	3,468	1·506
Helmsdale,	16,669	4·15	18,360	4·71	17,148	4·93	13,143	3·84	12,752	3·85	10,330	3·606
Cromarty,	19,193	2·93	15,317	2·51	14,736	2·48	12,428	2·065	11,183	1·815	11,070	1·839
Findhorn,	68,761	4·86	63,521	4·46	46,694	2·66	30,770	2·088	31,825	1·957	21,724	2·31
Buckie,	50,489	4·66	57,450	5·05	50,007	4·77	41,102	4·24	34,915	3·357	22,855	3·209
Banff,	76,491	4·77	66,471	3·82	61,329	3·70	36,057	2·13	26,675	2·406	18,471	1·834
Total,	258,589	4·43	256,916	4·26	241,350	3·83	169,321	3·244	147,775	2·666	111,845	2·600

With the exception of the Wick district, almost all the line-caught fish landed on the shores of the Moray Firth are caught in the Firth. The gross quantity last year, viz., 111,845 cwts., is the lowest since these statistics began to be collected, and the average catch per shot is also slightly lower, viz., 2·60 cwts., as compared with 2·66 in the previous year.

The quantity landed in 1900 was 35,930 cwts. less than in the year before, 57,476 cwts. less than in 1898, 129,505 cwts. less than in 1899, and 146,744 cwts. less than 1895. During the six years, therefore, a progressive decline has occurred in the quantity of fish taken by line-fishermen from the closed waters, the gross catch last year having been considerably under half of what it was in 1895. The average catch per "shot" has also fallen in the same period. In 1895 it was 4·43 cwts.; in 1896, almost the same, viz., 4·26 cwts.; in 1897, 3·83 cwts.; in 1898, 3·24 cwts.; in 1899, 2·66 cwts.; and last year, 2·60 cwts. The decline in line-fishing was not confined to the Moray Firth, but was shown also on other parts of the coast, the total quantity of line-caught fish landed being almost 182,000 cwts. less than in 1899, and 722,238 cwts. under the total catch in 1895. On the East Coast, including the Moray Firth, the decrease in the year amounted to 145,346 cwts.

The decrease in the quantity caught by line in the Moray Firth was shared by each of the seven districts, although unequally. The greatest decline was exhibited in the Findhorn and Buckie districts, and the least in Cromarty district. In the former the quantity landed in 1899 was 31,825 cwts., last year it was 21,724 cwts., showing a decrease of a little over 10,000 cwts. In Buckie district the quantity landed in 1899 was 34,915 cwts., while last year it was 22,855 cwts., the decrease being over 12,000 cwts. Banff exhibited a decrease of more than 8000 cwts., and Helmsdale one of 2422 cwts.

With respect to the various kinds of fish caught by line in the Moray Firth, the quantities and averages per "shot" for each of the past six years are given in the following Table:—

FISH.	1895.		1896.		1897.		1898.		1899.		1900.	
	Cwts.	Average.	Cwts.	Average.	Cwts.	Average.	Cwts.	Average.	Cwts.	Average.	Cwts.	Average.
Cod	47,646	0·81	64,663	1·07	79,731	1·26	56,208	1·07	52,753	0·95	33,572	0·779
Ling	2,937	0·005	3,868	0·062	3,544	0·056	2,567	0·049	2,883	0·052	2,392	0·055
Torsk	24	—	94	—	25	—	43	—	82	—	18	—
Saithe	5,083	0·087	10,636	0·17	11,761	0·18	14,881	0·28	9,383	0·169	9,126	0·212
Haddock	178,370	3·056	156,703	2·6	126,031	2·004	81,098	1·554	68,075	1·229	54,887	1·275
Whiting	5,114	0·087	4,836	0·08	3,319	0·052	1,535	0·029	1,323	0·023	1,736	0·04
Turbot	—	—	15	—	16	—	13	—	60	—	4	—
Halibut	403	0·007	691	0·011	707	0·011	730	0·013	702	0·013	253	0·005
Lemon Sole	—	—	19	—	14	—	1	—	6	—	4	—
"Flounder, Plaice, and Brill"	5,765	0·09	3,402	0·056	3,978	0·063	3,425	0·065	5,005	0·09	4,242	0·098
Conger	777	0·013	823	0·013	1,533	0·024	826	0·015	741	0·013	333	0·007
Skate	3,014	0·051	3,683	0·061	3,999	0·063	3,273	0·062	3,584	0·064	2,509	0·058
Other kinds	9,456	0·16	7,483	0·12	6,663	0·105	4,574	0·087	3,116	0·056	2,769	0·064

The quantity of all line-caught fish landed last year, with the exception of whitings, showed a decrease. This was most marked in cod and haddock, the two fishes which form the bulk of the catches. In 1899 the quantity of cod was 52,753 cwts., last year it was 33,572 cwts., a decline of more than 19,000 cwts. The yield of haddocks in 1899 was 68,075 cwts., while last year it was 54,887 cwts., a decline of over 13,000 cwts. A few years ago the quantity of cod and haddock taken was very much greater. In 1895 the quantity of cod landed was 47,646 cwts., in 1897 it was 79,731 cwts. The quantity of haddocks landed in 1895 was 178,370 cwts., and since that year it has steadily decreased. Less cod was landed in all the districts last year than the year before, and less haddocks at Banff, Buckie, Findhorn, and Lybster, while there were slight increases at Wick, Helmsdale, and Cromarty. Ling is not taken in great numbers in the Moray Firth, and the quantities caught have not fluctuated very much in different years. In 1899 the amount landed was 2883 cwts., as compared with 2392 cwts. in 1900, the decrease in the latter year being thus 491 cwts.

The next most abundant line-caught fish is the saithe, and the decrease in this case is also inconsiderable; viz., 257 cwts.; the quantity landed in 1899 was 9383 cwts., last year it was 9126 cwts., and the average per "shot" was somewhat higher. Whiting is exceptional among round-fishes in presenting an increase, the quantity landed in 1899 having been 1323 cwts., while last year it was 1736 cwts., an increase of 413 cwts., and the average per "shot" was also greater. The statistics for previous years exhibited a gradual decline in the quantity of this fish caught, falling from 5845 cwts. in 1894 to the amount stated for 1899.

The quantity of conger landed last year was less than half the amount for the year before, but in both cases the numbers were small, viz., 741 cwts. in 1899 and 333 cwts. in 1900. Skates also showed a

considerable falling off, from 3584 cwts. in 1899 to 2509 cwts. last year, a decrease of 1075 cwts.; and "other kinds of white fish," which include hake, lythe, catfish, etc., declined from 3116 cwts. to 2769 cwts., a difference of 347 cwts.

Among flat-fishes, which, however, are caught in relatively small proportion by lines, there was a decrease in turbot, viz., from a total of 60 cwts. in 1899 to a total of 4 cwts. in 1900. They were landed in the Wick district. The group which is classified in the returns as "flounders, plaice, and brill" showed a diminution from 5005 cwts. to 4242 cwts., the decrease amounting to 763 cwts., although the average per "shot," according to the returns, was practically the same. There is at present no means of showing how much of the decrease mentioned occurred in flounders, or in plaice, or in brill, or whether dabs and other kinds of flat-fish caught by line and not named in the heading are included in this column. Halibut is not caught in great quantity in the Moray Firth in any year, but the decline last year was relatively great, viz., from 762 to 253 cwts. The quantity of lemon soles taken by lines is still less. It was 4 cwts. last year and 6 cwts. the year before.

The statistics dealing with the number of "shots" of the line-fishing boats in the Moray Firth, or the number of trips to the fishing grounds, show that the increase noted last year has not been maintained. The number of shots both of the large and the small boats diminished in 1900 compared with 1899, the decrease being especially marked in the large or great-line boats. The figures for the past seven years are as follows:—

	1894	1895	1896	1897	1898	1899	1900
Large Boats,	7,082	7,710	11,915	14,039	10,330	12,665	5,595
Small Boats,	54,866	50,643	48,346	48,836	41,853	42,808	33,572
	61,948	58,353	60,261	62,875	52,183	55,473	39,167

It will be observed that in both cases the numbers are much below those of any previous year. There were 7070 fewer shots of the large boats, and 9236 fewer shots of the small boats, the combined decrease being 16,306 shots. The cause of this decay in line fishing is no doubt to be sought rather in the general conditions of the fishing industry than in the condition of the Moray Firth, since it is manifested on other parts of the coast.

The detailed statistics for each of the districts are as follows:—

Year.	Wick.		Lybster.		Helmsdale.		Cromarty.		Findhorn.		Buckie.		Banff.	
	Large.	Small.	Large.	Small.	Large.	Small.	Large.	Small.	Large.	Small.	Large.	Small.	Large.	Small.
1894	396	7,295	22	876	199	4,288	83	6,871	3,132	10,544	2,422	9,104	828	15,888
1895	1,553	4,155	90	965	366	3,614	12	6,561	2,653	11,481	1,929	8,907	1,107	14,930
1896	2,774	3,063	208	1,266	363	3,585	13	6,078	3,772	10,450	2,935	8,420	1,850	15,534
1897	3,911	3,266	264	1,440	466	3,010	3	5,918	4,738	12,810	2,537	7,943	2,120	14,449
1898	1,918	2,846	148	1,211	448	2,971	2	6,015	4,148	10,577	1,958	7,727	1,708	10,506
1899	1,865	3,249	1,932	1,149	382	2,930	61	6,146	5,377	10,883	1,940	8,476	1,108	9,975
1900	1,524	3,751	1,563	766	246	2,563	—	6,019	1,123	8,279	707	6,441	432	9,628

In all districts there was a decrease in the number of shots of the large boats, and also of the small boats except in the case of Wick. The most marked falling off was in the districts of Findhorn, Buckie, and Banff. In Findhorn district the number of shots made by the large boats declined from 5377 in 1899 to 1123 last year, in Banff district the decline was from 1108 to 432, and in Buckie district from 1940 to 707.

T. WEMYSS FULTON,

Scientific Superintendent.

TABLE A.—Showing Summary of Fish taken by the 'Garland' in Trawling Operations in 1900.

Station and Date.	Flat-Fish.									Round-Fish.							
	Plaice.	Lemon Soles.	Witch Soles.	Common Dabs.	Long Rough Dabs.	Flounders.	Turbot.	Brill.	Total.	Cod.	Haddocks.	Whitings.	Gurnards.	Total.	Skate.	Other Fish.	Total.
Moray Firth.																	
Station I.																	
Feb. 8,	11	.	.	.	.	.	.	.	11	.	.	.	.	.	.	.	11
April 18,	13	.	.	3	.	.	.	.	16	1	.	1	.	2	.	1	19
May 11,	31	.	.	9	.	.	.	.	40	.	.	1	16	17	1	2	60
June 6,	18	.	.	20	.	.	.	.	38	.	.	.	11	11	.	1	50
Dec. 12,	26	1	.	9	.	.	.	1	37	.	1	.	2	3	2	.	42
	99	1	.	41	.	.	.	1	142	1	1	2	29	33	3	4	182
Station II.																	
Jan. 17,	1	1	2	48	23	.	.	.	75	.	1	8	.	9	3	1	88
Feb. 7,	.	1	7	1	8	.	.	.	17	2	8	7	.	17	.	3	37
April 9,	1	.	.	2	2	.	.	.	5	.	.	1	.	1	1	.	7
May 7,	14	.	.	19	1	.	.	.	34	.	.	.	5	5	.	.	39
June 5,	4	2	4	17	17	.	.	.	44	.	.	.	5	5	.	.	49
Dec. 3,	6	1	.	19	4	.	.	.	30	2	.	7	5	14	.	.	44
	26	5	13	106	55	.	.	.	205	4	9	23	15	51	4	4	264
Station III.																	
Jan. 17,	16	5	.	5	.	.	.	.	26	29	.	.	.	29	.	11	66
Feb. 5,	24	4	.	1	.	.	.	.	29	28	.	2	.	30	.	1	60
April 12,	20	1	.	1	.	1	.	.	23	6	.	1	.	7	.	.	30
May 7,	7	.	.	.	.	.	.	.	7	.	.	.	.	.	.	.	7
June 4,	17	1	.	2	.	.	.	.	20	1	.	.	2	3	.	1	24
Nov. 30,	16	10	.	.	.	.	.	.	26	35	5	16	.	56	8	4	94
	100	21	.	9	.	1	.	.	131	99	5	19	2	125	8	17	281
Station IV.																	
Jan. 19,	23	.	.	7	.	.	.	.	30	.	.	.	.	.	1	.	31
Feb. 13,	71	.	.	2	.	5	.	.	78	.	.	.	.	.	3	.	81
April 10,	43	.	.	1	.	2	.	.	46	.	1	1	.	2	3	.	51
May 8,	165	.	.	32	1	.	.	.	198	.	.	.	1	1	5	.	204
June 11,	11	.	.	11	.	.	.	.	22	.	.	1	6	7	2	1	32
Dec. 6,	55	.	.	29	.	.	.	2	86	7	2	3	.	12	2	1	101
	368	.	.	82	1	7	.	2	460	7	3	5	7	22	16	2	500
Station V.																	
Jan. 19,	10	.	.	25	3	.	.	.	38	.	.	.	.	.	.	.	38
Feb. 13,	17	.	.	5	.	3	.	.	25	.	.	.	.	.	.	.	25
April 11,	62	.	.	61	.	5	.	.	128	.	12	3	.	15	1	.	144
May 8,	80	1	.	58	.	.	.	.	139	.	.	.	24	24	2	.	165
June 11,	27	1	.	57	.	.	.	.	85	2	1	1	8	12	.	1	98
Dec. 5,	23	.	.	86	3	.	.	.	112	1	1	4	1	7	1	.	120
	219	2	.	292	6	8	.	.	527	3	14	8	33	58	4	1	590

TABLE A.—SHOWING SUMMARY OF FISH TAKEN BY THE 'GARLAND' IN TRAWLING OPERATIONS IN 1900—*continued.*

Station and Date.	Flat-Fish.									Round-Fish.					Skate.	Other Fish.	Total.
	Plaice.	Lemon Soles.	Witch Soles.	Common Dabs.	Long Rough Dabs.	Flounders.	Turbot.	Brill.	Total.	Cod.	Haddocks.	Whitings.	Gurnards.	Total.			
MORAY FIRTH—*continued.*																	
Station VI.																	
Jan. 19,	6	.	2	7	.	.	.	.	15	.	.	.	.	.	.	.	15
Feb. 13,	45	1	.	39	9	3	.	.	97	1	3	.	.	4	6	.	107
April 11,	124	.	.	44	1	7	1	.	177	.	1	.	.	1	4	1	183
May 8,	45	3	.	35	3	.	.	.	86	.	.	1	18	19	2	.	107
June 11,	32	7	.	40	.	.	.	.	86	.	1	.	4	5	.	2	93
Dec. 5,	12	.	.	44	1	.	.	.	57	1	.	.	1	2	5	1	65
	271	11	2	209	14	10	1	.	518	2	5	1	23	31	17	4	570
Station VII.																	
Jan. 24,	.	2	1	68	21	.	.	.	92	.	8	6	.	14	.	3	109
Feb. 12,	5	4	1	57	34	.	.	.	101	1	23	4	.	28	1	10	140
April 11,	.	10	5	32	28	.	.	.	75	2	3	4	2	11	.	2	88
June 12,	.	9	7	115	68	.	.	.	199	1	3	1	44	49	.	5	253
Dec. 19,	.	6	12	348	50	.	.	.	416	3	144	16	1	164	1	6	587
	5	31	26	620	201	.	.	.	883	7	181	31	47	266	2	26	1177
Station VIII.																	
Jan. 31,	.	7	13	68	42	.	.	.	130	.	20	8	.	28	1	.	159
Feb. 9,	.	4	3	30	41	.	.	.	78	.	3	.	.	3	2	.	83
April 20,	2	2	18	48	57	.	.	.	127	1	35	13	11	60	1	2	190
June 13,	.	13	9	118	101	.	.	.	241	.	1	.	21	22	1	8	272
Dec. 18,	5	3	.	173	55	.	.	.	236	.	61	9	11	81	.	3	320
	7	29	43	437	296	.	.	.	812	1	120	30	43	194	5	13	1024
Station IX.																	
Jan. 31,	1	5	3	120	85	.	.	1	215	.	13	8	7	28	2	3	248
Feb. 9,	.	5	2	54	82	.	.	.	*146	.	5	.	19	24	5	5	180
April 20,	1	2	2	21	60	.	.	.	86	.	15	2	8	25	1	3	115
June 14,	2	9	2	108	56	.	.	.	177	.	5	.	30	35	.	3	215
Dec. 18,	1	1	.	139	65	.	.	.	206	.	43	11	11	65	1	.	272
	5	22	9	442	348	.	.	1	830	.	81	21	75	177	9	14	1030
Station X.																	
Jan. 31,	3	.	.	36	.	.	.	.	39	.	.	.	2	2	.	1	42
Feb. 9,	5	.	.	35	.	.	.	.	40	.	.	.	.	.	.	.	40
April 19,	.	8	.	31	19	.	.	.	†59	.	7	1	4	12	.	1	72
June 14,	2	9	.	81	14	.	.	.	106	1	1	.	9	11	1	12	130
Dec. 14,	5	7	13	90	61	.	.	.	†177	2	139	23	21	185	1	1	364
	15	24	13	273	94	.	.	.	421	3	147	24	36	210	2	15	648
Station XI.																	
April 23,	4	1	.	14	.	.	.	.	19	3	20	1	10	34	.	3	56
May 30,	2	12	.	124	2	.	.	.	140	2	4	1	44	51	.	3	194
June 21,	1	21	.	99	1	.	.	.	122	.	17	1	9	27	1	6	156
	7	34	.	237	3	.	.	.	281	5	41	3	63	112	1	12	406

* Includes 3 sail fluke. † Includes 1 sail fluke.

TABLE A.—Showing Summary of Fish taken by the 'Garland' in Trawling Operations in 1900—*continued.*

Station and Date.	Flat-Fish.									Round-Fish.					Skate.	Other Fish.	Total.
	Plaice.	Lemon Soles.	Witch Soles.	Common Dabs.	Long Rough Dabs.	Flounders.	Turbot.	Brill.	Total.	Cod.	Haddocks.	Whitings.	Gurnards.	Total.			
Moray Firth—*continued*.																	
Station XII.																	
April 23,	9	3	.	45	.	.	.	1	58	1	11	2	12	26	.	1	85
May 30,	2	29	.	172	2	.	.	1	206	3	11	5	49	68	.	4	278
June 21,	1	12	.	84	2	.	1	.	100	1	7	1	37	46	1	2	149
	12	44	.	301	4	.	1	2	364	5	29	8	98	140	1	7	512
Station XIII.																	
April 24,	3	7	.	33	4	.	.	.	47	.	18	4	8	30	.	1	78
May 31,	1	15	.	64	3	.	.	.	83	.	10	1	14	25	.	3	111
June 22,	4	16	.	33	.	.	.	.	53	4	7	.	32	43	2	1	99
	8	38	*.	130	7	.	.	.	183	4	35	5	54	98	2	5	288
Station XIV.																	
May 31,	1	42	.	23	30	.	.	.	*97	.	56	7	82	145	.	6	248
June 21,	.	39	.	42	17	.	.	.	98	.	6	1	88	95	5	1	199
	1	81	.	65	47	.	.	.	195	.	62	8	170	240	5	7	447
Station XV.																	
May 30,	4	5	.	70	19	.	.	.	*99	.	6	1	25	32	.	1	132
June 22,	2	14	.	165	19	.	1	.	201	.	3	.	58	61	.	6	268
	6	19	.	235	38	.	1	.	300	.	9	1	83	93	.	7	400
Station XVI																	
April 24,	.	9	2	66	44	.	.	.	121	.	25	6	36	67	4	6	198
May 31,	2	23	.	69	80	.	.	.	174	.	3	1	25	29	1	8	212
June 22,	1	15	1	24	24	.	.	.	65	6	14	2	29	51	.	36	152
	3	47	3	159	148	.	.	.	360	6	42	9	90	147	5	50	562

* Includes 1 sail fluke.

TABLE B.—ANALYSIS OF THE 'GARLAND'S' STATISTICS RELATING TO THE RELATIVE ABUNDANCE OF FISH.

Station.	Flat-Fish.									Round-Fish.					Skate.	Other Fish.	Total.
	Plaice.	Lemon Soles.	Witch Soles.	Common Dabs.	L. Rough Dabs.	Flounders.	Turbot.	Brill.	Total.	Cod.	Haddocks.	Whitings.	Gurnards.	Total.			
Moray Firth.																	
I.	19·8	0·2	–	8·2	–	–	–	0·2	28·4	0·2	0·2	0·4	5·8	6·6	0·6	0·8	36·4
II.	4·3	0·8	2·2	17·6	9·2	–	–	–	34·2	0·6	1·5	3·8	2·5	8·5	0·6	0·6	44·0
III.	16·6	3·5	–	1·5	–	0·2	–	–	21·8	16·5	0·8	3·2	0·3	20·8	1·3	2·8	46·8
IV.	61·3	–	–	13·6	0·2	1·2	–	0·3	76·6	1·2	0·5	0·8	1·2	3·6	2·6	0·3	83·3
V.	36·5	0·3	–	48·6	1·0	1·3	–	–	87·8	0·5	2·3	1·3	5·5	9·6	0·6	0·2	98·3
VI.	45·2	1·8	0·3	34·8	2·3	1·8	0·2	–	86·3	0·3	0·8	0·2	3·8	5·2	2·8	0·6	95·0
VII.	1·0	6·2	5·2	124·0	40·2	–	–	–	176·6	1·4	36·2	6·2	9·4	53·2	0·4	5·2	235·4
VIII.	1·4	5·8	8·6	87·4	59·2	–	–	–	162·4	0·2	24·0	6·0	8·6	38·8	1·0	2·6	204·8
IX.	1·0	4·4	1·8	88·4	69·6	–	–	0·2	166·0	–	16·2	4·2	15·0	35·4	1·8	2·8	206·0
X.	3·0	4·8	2·6	54·6	18·8	–	–	–	84·2	0·6	29·4	4·8	7·2	42·0	0·4	3·0	129·6
XI.	2·3	11·3	–	79·0	1·0	–	–	–	93·6	1·6	13·6	1·0	21·0	37·3	0·3	4·0	135·3
XII.	4·0	14·6	–	100·3	1·3	–	0·3	0·6	121·3	1·6	9·6	2·6	32·6	46·6	0·3	2·3	170·6
XIII.	2·6	12·6	–	43·3	2·3	–	–	–	61·0	1·3	11·6	1·6	18·0	32·6	0·6	1·6	96·0
XIV.	0·5	40·5	–	32·5	23·5	–	–	–	97·5	–	31·0	4·0	85·0	120·0	2·5	3·5	223·5
XV.	3·0	9·5	–	117·5	19·0	–	0·5	–	150·0	–	4·5	0·5	41·5	46·5	–	3·5	200·0
XVI.	1·5	23·5	1·5	79·5	74·0	–	–	–	180·0	3·0	21·0	4·5	45·0	73·5	2·5	25·0	281·0
Month.																	
January,	6·6	2·2	2·3	42·6	19·3	–	–	0·1	73·3	3·2	4·6	3·3	1·0	12·3	0·8	2·1	88·4
February,	17·8	1·9	1·3	22·4	17·4	1·1	–	–	62·2	3·2	4·2	1·3	1·9	10·6	1·7	1·9	76·4
April,	20·1	3·1	1·9	28·7	15·4	1·1	0·1	0·1	70·5	1·0	10·6	2·9	6·5	20·9	1·1	1·5	94·0
May,	29·5	10·8	–	56·2	11·7	–	–	0·1	108·6	0·4	7·5	1·5	25·2	34·6	0·9	2·2	146·4
June,	8·1	10·5	1·4	63·5	19·9	–	0·1	–	103·6	1·0	4·1	0·5	24·6	30·2	0·8	5·4	139·9
December,	14·9	2·9	2·5	93·7	23·9	–	–	0·3	138·3	5·1	39·6	8·9	5·3	58·9	2·1	1·6	200·9

TABLE C.—Record of Observations made on Board the "Garland" during 1900.

A. FISH CAUGHT—Moray Firth.

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																			Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
Station I.																					
1900.																					
Feb. 8.	Plaice,	.	.	.	.	.	.	.	.	3	5	3	.	.	.	.	.	.	.	.	11
1-50 p.m. to 3-17 p.m.																					
April 18.	Cod,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
0-37 p.m.	Whiting,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
to	Sand-eel,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
2-30 p.m.	Plaice,	.	.	1	.	.	.	.	.	2	2	4	1	.	1	1	.	1	.	.	13
	Common dab,	.	.	1	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
																					19
May 11.	Common gurnard,	.	.	1	.	1	1	3	3	2	2	.	2	1	.	.	.	.	.	.	16
11-5 a.m. to	Cat-fish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*1
1-5 p.m.	Dragonet,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Whiting,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
	Plaice,	.	.	.	.	.	.	2	6	3	5	6	.	1	4	2	1	.	.	1	31
	Common dab,	.	.	2	1	.	.	2	1	1	2	.	.	.	.	.	.	.	.	.	9
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1
																					60
June 6.	Common gurnard,	.	.	1	2	1	4	3	.	.	.	.	.	.	.	.	.	.	.	.	11
0-22 p.m.	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1
to	Plaice,	1	.	.	.	.	.	.	.	.	3	2	4	2	2	.	1	.	.	1	†18
2-22 p.m.	Common dab,	3	11	2	1	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	20
																					50
Dec. 12.	Common gurnard,	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	2
11-55 a.m.	Haddock,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
to	Brill,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
2 5 p.m.	Plaice,	.	.	.	.	.	.	.	2	2	2	6	4	4	1	1	2	1	.	.	‡26
	Common dab,	1	5	1	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	9
	Lemon sole,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Thornback skate,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	2
Station																					42
1900.																					
Jan. 17.	Cat-fish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	§1
8-40 a.m.	Haddock,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
to	Whiting,	.	.	.	.	4	1	3	.	.	.	.	.	.	.	.	.	.	.	.	8
10-30 a.m.	Long rough dab,	.	4	8	4	4	3	.	.	.	.	.	.	.	.	.	.	.	.	.	23
	Plaice,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Lemon sole,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Witch sole,	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	2
	Common dab,	13	9	8	9	5	2	.	2	.	.	.	.	.	.	.	.	.	.	.	48
	Thornback skate,	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	3
																					88

* 36 inches. † Two 22 inches. One 26 inches 36 inches.

TABLE C.—Record of Observations made on Board the "Garland" during 1900.

A. FISH CAUGHT—Moray Firth—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																			Total
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
StationII.																					
1900.																					
Feb. 7.	Cod,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
8-55 a.m.	Haddock,	.	.	.	.	.	.	.	1	2	2	2	1	.	.	.	.	.	.	.	.	8
to	Whiting,	.	1	3	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7
10-28 a.m.	Long rough dab,	.	1	4	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8
	Lemon sole,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
	Witch sole,	.	.	.	.	.	.	.	.	.	.	2	.	2	3	.	.	.	.	.	.	7
	Common dab,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Herring,	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
																					37
April 9.	Whiting,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
11-40 a.m.	Long rough dab,	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
to	Plaice,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
1-40 p.m.	Common dab,	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1
																					7
May 7.	Common gurnard,	.	1	2	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
0-17 p.m.	Long rough dab,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
to	Plaice,	.	1	2	5	1	2	2	.	1	.	.	.	.	.	.	.	.	.	.	.	14
2-18 p.m.	Common dab,	2	6	3	6	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	19
																					39
June 5.	Common gurnard,	.	1	2	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	5
10-6 a.m.	Long rough dab,	.	1	3	9	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	17
to	Plaice,	.	.	.	1	1	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	4
0-7 p.m.	Lemon sole	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Witch sole,	.	.	.	.	.	.	.	.	.	.	.	.	2	2	.	.	.	.	.	.	4
	Common dab,	3	8	1	1	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*17
																					49
Dec. 3.	Common gurnard,	.	2	1	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	5
11-35 a.m.	Cod,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	2
to	Whiting,	1	1	3	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7
1-35 p.m.	Long rough dab,	.	.	2	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Plaice,	.	.	.	.	.	1	2	.	1	.	.	1	.	.	.	.	.	.	1	.	6
	Lemon sole,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Common dab,	5	8	1	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	†19
																					44
Station III.																					
Jan. 17.	Cod,	.	2	10	9	2	1	.	.	1	2	.	1	1	.	.	.	.	.	.	.	29
11-37 a.m.	Pollack,	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
to	Saithe,	.	.	.	.	1	.	1	5	1	.	.	.	.	.	.	.	.	.	.	.	8
0-35 p.m.	Plaice,	.	.	.	.	.	.	.	3	3	4	2	1	1	.	.	1	.	1	.	.	16
	Lemon sole,	.	.	.	1	1	.	1	.	2	.	.	.	.	.	.	.	.	.	.	.	5
	Common dab,	.	.	2	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
																					66
Feb. 5.	*Cottus scorpius*,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
3-18 p.m.	Cod,	.	.	5	6	4	1	1	.	3	1	1	2	1	2	.	.	1	.	.	.	28
to	Whiting,	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	2
4-25 p.m.	Plaice,	.	.	.	.	.	.	3	1	3	9	3	5	.	.	.	.	.	.	.	.	24
	Lemon sole,	.	.	.	.	.	.	2	.	1	1	.	.	.	.	.	.	.	.	.	.	4
	Common dab,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
																					60

* One 3 inches. † Two 3 inches.

TABLE C.—Record of Observations made on Board the "Garland" during 1900.

A. FISH CAUGHT—Moray Firth—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																		Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
Station III.																						
1900.	Cod,	.	.	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
April 12.	Whiting,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
1-50 p.m.	Flounder,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
to	Plaice,	.	.	.	.	1	2	1	4	6	3	1	.	1	.	1	.	.	.	.	.	20
2.45 p.m.	Lemon sole,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Common dab,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
																						30
May 7.	Plaice,	.	.	.	.	.	.	1	.	.	4	2	.	.	.	.	.	.	.	.	.	7
9-35 a.m.																						
to																						
10-35 a.m.																						
June 4.	Common gurnard,	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
2-15 p.m.	Father-lasher,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
to	Cod,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
3-32 p.m.	Plaice,	.	.	.	.	.	.	.	4	3	5	4	.	.	.	1	.	.	.	.	.	17
	Lemon sole,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
	Common dab,	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
																						24
Nov. 30.	Butter-fish,	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
0-5 p.m.	Dragonet,	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
to	Cod,	1	2	7	2	.	1	3	5	6	1	1	1	.	.	.	2	1	1	.	.	*35
1-30 p.m.	Haddock,	.	.	.	.	.	.	.	.	.	.	1	.	2	1	.	.	.	1	.	.	5
	Whiting,	1	9	3	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	16
	Plaice,	.	.	.	.	.	.	.	1	1	3	.	4	3	1	.	.	1	2	.	.	16
	Lemon sole,	.	.	1	.	1	1	2	.	2	2	1	.	.	.	.	.	.	.	.	.	10
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	3	2	1	.	8
																						94
Station IV.																						
1900.																						
Jan. 19.	Plaice,	.	.	.	.	.	.	1	3	13	6	.	.	.	.	.	.	.	.	.	.	23
8-55 a.m.	Common dab,	1	5	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7
to	Thornback skate,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
10-40a.m.																						31
Feb. 13.	Flounder,	.	.	.	.	.	2	1	.	2	.	.	.	.	.	.	.	.	.	.	.	5
10-48 a.m.	Plaice,	1	.	.	.	.	6	11	11	19	20	2	.	.	.	.	.	.	.	.	.	†71
to	Common dab,	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	2
0-30 p.m.	Thornback skate,	.	.	.	1	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	3
																						81
April 10.	Haddock,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
10-55 a.m.	Whiting,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
to	Flounder,	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	2
0-55 p.m.	Plaice,	7	2	2	1	5	4	11	2	1	4	3	.	.	.	.	.	.	.	.	.	†43
	Common dab,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
	Thornback skate,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	3
																						51
May 8.	Common gurnard,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
3-15 p.m.	Long rough dab,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
to	Plaice,	25	14	23	11	11	8	14	9	17	17	8	3	.	.	.	.	.	4	.	.	‡165
5-15 p.m.	Common dab,	.	7	12	4	1	2	1	2	2	1	.	.	.	.	.	.	.	.	.	.	32
	Thornback skate,	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	3	.	.	.	.	5
																						204

* One 28 inches. † One 3 inches ‡ One 26 inches

TABLE C.—Record of Observations made on Board the "Garland" during 1900.

A. FISH CAUGHT—Moray Firth—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																		Total
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
Station IV.																						
1900.	Common gurnard,	.	.	2	.	2	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	
June 11.	Angler,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	
2-5 p.m.	Whiting,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
to	Plaice,	2	2	.	1	.	.	.	2	.	1	1	1	.	.	.	.	.	.	.	.	*1
4-5 p.m.	Common dab,	1	6	2	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	
																						3
Dec. 6.	Father-lasher,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
9-40 a.m.	Cod,	.	.	2	4	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
to	Haddock,	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	
0-10 p.m.	Whiting,	.	.	.	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Brill,	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	
	Plaice,	.	.	.	.	1	1	4	5	9	10	12	5	7	1	.	.	.	.	.	.	5
	Common dab,	2	16	2	2	2	2	.	2	1	.	.	.	.	.	.	.	.	.	.	.	2
	Thornback skate,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.	
																						10
Station V.																						
1900.	Long rough dab,	.	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Plaice,	.	.	.	.	.	.	1	1	6	1	.	.	.	.	.	.	.	.	.	.	1
Jan. 19.	Common dab,	10	14	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	†2
11-8 a.m.																						3
to																						
0-37 p.m.																						
Feb. 13.	Flounder,	.	.	.	.	2	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	
0-51 p.m.	Plaice,	.	.	.	.	.	.	4	1	3	7	2	.	.	.	.	.	.	.	.	.	1
to	Common dab,	1	.	.	.	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
2-17 p.m.																						2
April 11.	Haddock,	.	.	.	.	.	.	.	.	.	5	2	1	1	.	1	.	.	1	1	.	1
7-35 a.m.	Whiting,	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	‡
to	Flounder,	.	.	1	.	.	1	1	.	.	2	.	.	.	.	.	.	.	.	.	.	
9-35 a.m.	Plaice,	6	3	4	4	7	11	7	4	5	6	1	1	.	.	1	.	.	.	2	.	6
	Common dab,	12	9	15	9	12	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	6
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	
																						14
May 8.	Com. gurnard,	.	.	5	5	6	3	3	.	1	.	1	.	.	.	.	.	.	.	.	.	2
0-50 p.m.	Plaice,	2	7	10	12	7	18	4	.	5	6	5	1	1	.	.	.	.	1	1	.	8
to	Lemon sole,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
2-50 p.m.	Common dab,	.	15	25	7	8	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	5
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	
																						16
June 11	Com. gurnard,	1	.	4	.	1	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	
11-30 a.m.	Cat-fish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	‡
to	Cod,	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	
1-30 p.m.	Haddock,	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	
	Whiting,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Plaice,	.	3	5	5	4	3	.	2	.	1	1	1	.	.	.	.	.	1	1	.	2
	Lemon sole,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Common dab,	8	19	17	10	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	†5
																						9

* One 28 inches. † One 3 inches. ‡ 30 inches.

TABLE C.—Record of Observations made on Board the "Garland" during 1900.

A. FISH CAUGHT—Moray Firth—*continued.*

Station, Date, and Time Trawl Down.	Kind of Fish.	Size in Inches.																			Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
Station V.																					
1900.	Com. gurnard,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*1
	Cod,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Dec. 5.	Haddock,	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1
11-49 a.m.	Whiting,	1	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
to	Long rough dab,	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
1-50 p.m.	Plaice,	.	.	1	.	1	.	1	2	6	5	2	2	2	1	.	.	.	.	.	.	23
	Common dab,	14	43	21	5	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	86
	Thornback skate,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
Station VI.																					120
1900.																					
Jan. 19.	Plaice,	.	.	.	.	.	.	.	.	4	1	.	1	.	.	.	.	.	.	.	.	6
1-1 p.m.	Witch sole,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	2
to	Common dab,	2	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7
2-25 p.m.																					15
Feb. 13.	Cod,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
2-48 p.m.	Haddock,	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	1	.	.	.	.	3
to	Long rough dab,	.	5	4	.	.	.	.	2	.	1	.	.	.	.	.	.	.	.	.	.	12
4-20 p.m.	Flounder,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
	Plaice,	.	.	1	1	1	2	5	1	8	12	13	1	.	.	.	.	.	.	.	.	45
	Lemon sole,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
	Common dab,	2	14	15	6	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	39
	Thornback skate	.	.	.	.	.	.	1	.	.	1	1	.	.	.	2	.	1	.	.	.	6
																					107
April 11.	Cat-fish,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	†1
9-57 a.m.	Haddock,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
to	Long rough dab,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
11-37 a.m.	Turbot,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
	Flounder,	.	.	.	.	1	.	2	1	3	.	.	.	.	.	.	.	.	.	.	.	7
	Plaice,	6	4	8	12	16	11	7	24	14	10	8	1	.	.	.	.	.	1	1	.	*124
	Common dab,	5	10	8	13	3	4	1	.	.	.	.	.	.	.	.	.	.	.	.	.	44
	Thornback skate	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	1	.	1	.	.	4
																					183
May 8.	Com. gurnard,	.	1	5	3	4	4	.	.	.	.	1	.	.	.	.	.	.	.	.	.	18
10-10 a.m.	Whiting,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
to	Long rough dab,	.	.	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
11-49 a.m.	Plaice,	1	.	3	8	3	9	2	1	3	3	5	1	1	.	.	.	1	1	3	.	45
	Lemon sole,	.	.	.	.	1	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	3
	Common dab,	1	12	9	8	4	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	35
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	2
																					107
June 11.	Com. gurnard,	.	1	.	.	1	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	4
5-35 p.m.	Cat-fish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	‡1
to	Dragonet,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
7-0 p.m.	Haddock,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
	Plaice,	6	4	4	2	2	2	.	.	7	5	3	2	1	1	.	.	.	.	.	.	39
	Lemon sole,	.	.	.	4	.	.	.	2	1	.	.	.	.	.	.	.	.	.	.	.	7
	Common dab,	3	9	17	8	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	40
																					93
Dec. 5.	Com. gurnard	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
9-55 a.m.	Dragonet	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
to	Cod,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
0-25 p.m.	Long rough dab,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Plaice,	.	.	.	.	.	.	1	1	4	2	2	2	.	.	.	.	.	.	.	.	12
	Common dab,	10	18	12	1	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	44
	Thornback skate,	.	.	1	.	.	1	1	1	.	.	1	.	.	.	.	.	.	.	.	.	5
																					65

* One 3 inches. † 36 inches. ‡ 33 inches.

ABLE C.—Record of Observations made on Board the "Garland" during 1900.

A. FISH CAUGHT—Moray Firth—*continued.*

ion, and ne wl rn.	Kind of Fish.	Size in Inches.																			Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
ion L																					
0.	Haddock,	.	.	.	1	.	.	.	2	4	1	.	.	.	.	.	.	.	.	.	.	8
	Brassie,	.	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
24.	Whiting,	.	.	.	.	3	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
a.m.	Long rough dab,	2	4	8	5	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	21
	Lemon sole,	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	2
p.m.	Witch sole,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Common dab,	6	20	25	15	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	68
																						109
12.	Angler,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	2
p.m.	Dragonet,	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Cod,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
p.m.	Haddock,	.	.	.	.	.	.	2	3	7	9	1	1	.	.	.	.	.	.	.	.	23
	Brassie,	.	.	.	2	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
	Whiting,	.	.	.	.	1	1	.	2	.	.	.	.	.	.	.	.	.	.	.	.	4
	Long rough dab,	.	12	11	9	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	34
	Plaice,	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	1	1	1	.	.	5
	Lemon sole,	.	.	1	.	.	.	.	.	.	2	1	.	.	.	.	.	.	.	.	.	4
	Witch sole,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
	Common dab,	1	18	30	4	3	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	57
	Starry-ray,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
																						140
11.	Com. gurnard,	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	2
.m.	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*1
	Cod,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	2
.m.	Haddock,	.	.	.	.	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	3
	Whiting,	.	.	.	.	.	1	3	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Three-bearded rockling,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
	Long rough dab,	1	6	10	8	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	28
	Lemon sole,	.	.	.	1	1	.	.	.	1	2	4	.	.	1	.	.	.	.	.	.	10
	Witch sole,	.	.	.	.	.	1	.	2	1	.	.	.	.	1	.	.	.	.	.	.	5
	Common dab,	.	6	16	4	3	1	1	.	1	.	.	.	.	.	.	.	.	.	.	.	32
																						88
12.	Com. gurnard,	1	13	20	5	2	.	1	1	.	.	.	1	.	.	.	.	.	.	.	.	44
a.m.	Cat-fish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	†1
	Cod,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
a.m.	Haddock,	.	.	.	.	.	.	.	1	2	.	.	.	.	.	.	.	.	.	.	.	3
	Whiting,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Hake,	.	.	.	.	.	.	1	.	1	.	.	.	*	.	.	.	.	.	.	.	2
	Three-bearded rockling,	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Long rough dab,	.	10	33	19	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	68
	Lemon sole,	.	1	3	.	1	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	9
	Witch sole,	.	.	.	.	1	1	3	.	2	.	.	.	.	.	.	.	.	.	.	.	7
	Common dab,	4	34	53	22	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	115
																						253
19.	Com. gurnard,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
a.m.	Angler,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
	Dragonet,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
.m.	Cod,	.	.	.	.	.	2	.	.	1	.	.	.	.	.	.	.	.	.	.	.	3
	Haddock,	.	1	12	4	.	9	58	43	11	4	2	.	.	.	.	.	.	.	.	.	144
	Whiting,	.	.	.	.	4	4	6	1	.	1	.	.	.	.	.	.	.	.	.	.	16
	Hake,	.	.	.	.	.	.	.	.	.	.	2	.	1	.	1	.	.	.	.	.	4
	Long rough dab,	1	3	23	18	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	50
	Lemon sole,	.	1	2	.	.	.	.	.	.	.	1	2	.	.	.	.	.	.	.	.	6
	Witch sole,	.	.	.	.	1	.	3	5	1	.	2	.	.	.	.	.	.	.	.	.	12
	Common dab,	7	107	164	58	13	7	.	.	.	.	.	.	.	.	.	.	.	.	.	.	348
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
																						587

* 39 inches. † 32 inches.

TABLE C.—Record of Observations made on Board the "Garland" during 190(

A. FISH CAUGHT—Moray Firth—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																				To
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
Station VIII.																						
1900.	Haddock,	.	.	4	1	.	.	.	4	3	6	2	.	.	.	.	.	.	.	.	.	
	Whiting,	.	.	.	.	1	3	1	.	1	1	.	1	.	.	.	.	.	.	.	.	
Jan. 31.	Long rough dab,	.	4	11	20	7	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
11-10 a.m.	Lemon sole,	.	.	2	1	.	.	.	1	.	.	2	.	1	.	.	.	.	.	.	.	
to	Witch sole,	.	.	.	2	.	3	2	.	.	5	.	.	.	1	.	.	.	.	.	.	
0-35 p.m.	Common dab,	8	22	21	12	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Starry-ray,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
Feb. 9.	Haddock,	.	.	.	.	.	.	.	.	2	.	.	1	.	.	.	.	.	.	.	.	
2-30 p.m.	Long rough dab,	.	7	17	11	5	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
to	Lemon sole,	.	1	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	
3-46 p.m.	Witch sole,	.	.	.	.	.	.	.	.	.	.	.	.	1	.	2	.	.	.	.	.	
	Common dab,	8	7	10	3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	
April 20.	Com. gurnard,	.	.	3	1	2	1	2	2	.	.	.	.	.	.	.	.	.	.	.	.	
5-37 a.m.	Angler,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
to	Cod,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
7.37 a.m.	Haddock,	.	.	4	14	5	.	2	4	5	1	.	.	.	.	.	.	.	.	.	.	
	Whiting,	.	.	.	.	2	6	2	1	2	.	.	.	.	.	.	.	.	.	.	.	
	Hake,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	
	Long rough dab,	1	11	20	23	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Plaice,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	
	Lemon sole,	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	
	Witch sole,	.	.	.	.	1	11	2	.	2	.	1	1	.	.	.	.	.	.	.	.	
	Common dab,	.	3	12	17	12	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1
June 13.	Com. gurnard,	.	1	7	10	2	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	
1-48 p.m.	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	
to	Cat-fish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	
3-48 p.m.	Haddock,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Hake,	.	.	.	.	.	.	.	.	.	1	2	.	.	.	.	.	.	.	.	.	
	Ling,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	
	Long rough dab,	.	11	47	36	7	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Lemon sole,	1	2	5	3	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	
	Witch sole,	.	.	.	.	.	1	2	2	1	.	1	.	1	1	.	.	.	.	.	.	1
	Common dab,	4	28	55	26	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Grey skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Dec. 18.	Com. gurnard,	.	3	1	4	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	
2-5 p.m.	Pogge,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
to	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	
3-55 p.m.	Dragonet,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Haddock,	.	.	35	15	.	3	7	1	.	.	.	.	.	.	.	.	.	.	.	.	
	Whiting,	.	.	.	.	8	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Long rough dab,	.	3	21	19	11	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Plaice,	.	.	.	.	.	.	.	.	.	.	1	1	1	1	1	.	.	.	.	.	
	Lemon sole,	.	.	1	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	
	Common dab,	9	68	61	23	7	2	2	1	.	.	.	.	.	.	.	.	.	.	.	.	1

* 52½ inches. † One 42 inches. ‡ 35 inches.

ABLE C.—Record of Observations made on Board the "Garland" during 1900.

A. FISH CAUGHT—Moray Firth—*continued.*

on, and ie wl n.	Kind of Fish.	Size in Inches. 4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	Total.
lon																						
0.	Com. gurnard,	.	.	1	1	1	2	1	1	.	.	.	.	.	.	.	.	.	.	.	.	7
	Haddock,	.	.	3	2	.	.	1	1	4	2	.	.	.	.	.	.	.	.	.	.	13
31.	Whiting,	.	.	.	.	4	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	8
ı.m.	Hake,	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	2
	Ling,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*1
ı.m.	Long rough dab,	2	18	38	22	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	85
	Brill,	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1
	Plaice,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
	Lemon sole,	.	.	.	.	1	1	2	.	.	1	.	.	.	.	.	.	.	.	.	.	5
	Witch sole,	.	.	.	.	.	.	.	.	.	1	2	.	.	.	.	.	.	.	.	.	3
	Common dab,	10	52	37	17	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	120
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1
	Starry-ray,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
																						248
9.	Com. gurnard,	2	5	7	2	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	19
ı.m.	Angler,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	†3
	Haddock,	.	.	.	.	.	.	.	.	3	2	.	.	.	.	.	.	.	.	.	.	5
ı.m.	Hake,	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	2
	Long rough dab,	1	9	32	31	9	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	82
	Sail-fluke,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	1	.	3
	Lemon sole,	.	.	.	.	1	2	.	.	.	2	.	.	.	.	.	.	.	.	.	.	5
	Witch sole,	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	2
	Common dab,	5	16	20	10	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	54
	Grey skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	1	.	2	.	1	.	.	.	.	4
																						150
20.	Com. gurnard,	.	3	2	.	.	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	8
ı.m.	Angler,	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	‡3
	Haddock,	.	.	1	7	2	.	1	.	2	1	1	.	.	.	.	.	.	.	.	.	15
a.m.	Whiting,	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Long rough dab,	2	23	22	13	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	60
	Plaice,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
	Lemon sole,	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	2
	Witch sole,	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Common dab,	1	2	7	5	3	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	21
	Cuckoo ray,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
																						115
14.	Com. gurnard,	.	4	9	8	7	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	30
ı.m.	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
	Cat-fish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	‡1
ı.m.	Haddock,	.	.	.	.	.	.	.	.	2	.	1	.	.	.	.	2	.	.	.	.	5
	Long rough dab,	.	13	25	17	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	56
	Topknot,	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
	Plaice,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Lemon sole,	.	5	2	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9
	Witch sole,	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	2
	Common dab,	15	36	32	18	7	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	108
																						215
18.	Com. gurnard,	.	.	5	.	2	1	3	.	.	.	.	.	.	.	.	.	.	.	.	.	11
ı.m.	Haddock,	.	.	11	7	.	11	13	1	.	.	.	.	.	.	.	.	.	.	.	.	43
	Whiting,	.	.	.	.	2	4	3	2	.	.	.	.	.	.	.	.	.	.	.	.	11
a.m.	Long rough dab,	.	11	28	24	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	65
	Plaice,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
	Lemon sole,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Common dab,	5	50	62	16	3	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	139
	White skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
																						272

* 36 inches. † One 54 inches. ‡ One 28 inches 31 inches.

TABLE C.—Record of Observations made on Board the "Garland" during 190(

A. FISH CAUGHT—Moray Firth—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																			To
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
Station X.																					
1900.	Com. gurnard,	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Pogge,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
Jan 31.	Plaice,	.	.	.	.	.	.	.	.	.	1	1	.	1	.	.	.	.	.	.	.	
2-10 p.m. to 3-15 p.m.	Common dab,	11	22	2	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
Feb. 9.	Plaice,	.	.	.	.	.	.	.	.	1	.	2	1	.	.	.	1	.	.	.	.	
8-43 a.m. to 10-9 a.m.	Common dab,	9	14	8	2	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	
April 19.	Com. gurnard,	.	.	2	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	
0-55 p.m.	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	
to	Haddock,	.	.	.	3	.	.	.	1	1	.	1	.	.	.	.	.	.	1	.	.	
2-55 p.m.	Whiting,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Long rough dab,	.	3	10	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Sail-fluke,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	
	Lemon sole,	.	1	1	.	1	.	1	.	.	2	1	.	1	.	.	.	.	.	.	.	
	Common dab,	19	5	1	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
June 14.	Com. gurnard,	.	.	6	.	.	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	
10-42 a.m.	Pogge,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
to	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	
0-45 p.m.	Dragonet,	.	2	1	.	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Cod,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Haddock,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	
	Ling,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	
	Long rough dab,	.	1	6	6	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Plaice,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	
	Lemon sole,	1	.	1	1	1	3	.	.	.	2	.	.	.	.	.	.	.	.	.	.	
	Common dab,	17	47	10	7	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	
	Cuckoo ray,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
Dec. 14.	Com. gurnard,	.	4	12	1	1	1	2	.	.	.	.	.	.	.	.	.	.	1	.	.	
8-20 a.m.	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
to	Cod,	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	
10-20 a.m.	Haddock,	.	.	5	4	.	10	58	37	7	13	4	1	.	.	.	.	.	.	.	.	1
	Whiting,	.	.	.	.	.	5	4	9	4	.	1	.	.	.	.	.	.	.	.	.	
	Long rough dab,	.	2	24	30	3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Sail-fluke,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	
	Plaice,	.	.	.	.	.	.	.	.	.	.	.	3	2	.	.	.	.	.	.	.	
	Lemon sole,	.	.	1	1	3	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	
	Witch sole,	.	.	.	.	1	.	3	4	4	.	1	.	.	.	.	.	.	.	.	.	
	Common dab,	.	15	30	31	12	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Thornback skate,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
Station XI.																					
1900.																					
April 23.	Com. gurnard,	.	.	2	.	1	1	2	3	1	.	.	.	.	.	.	.	.	.	.	.	
9-58 a.m.	Pogge,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
to	Cat-fish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
11-58 a.m.	Dragonet,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Cod,	.	.	.	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Haddock,	.	.	.	.	.	.	1	2	4	5	2	.	.	2	3	1	.	.	.	.	1
	Whiting,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Plaice,	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	2	.	.	.	
	Lemon sole,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	
	Common dab,	2	9	1	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1

* Three 3 inches. † One 28 inches. ‡ 38 inches.

TABLE C.—Record of Observations made on Board the "Garland" during 1900.

A. FISH CAUGHT—Moray Firth—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches. 4+	5+	6+	7+	8+	9+	10+	11+	12+	13+	14+	15+	16+	17+	18+	19+	20+	21+	23+	25+	Total
Station XI.																						
1900.	Com. gurnard,	.	.	2	8	12	10	8	3	1	.	.	.	.	.	.	.	.	.	.	.	4
	Pogge,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
May 30.	Dragonet,	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
3-40 p.m.	Cod,	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	
to	Haddock,	.	.	.	.	.	1	1	.	.	1	.	.	.	1	.	.	.	.	.	.	
5-40 p.m.	Whiting,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Long rough dab,	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Plaice,	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	
	Lemon sole,	.	2	2	2	2	1	.	.	.	1	1	1	.	.	.	.	.	.	.	.	1
	Common dab,	23	64	19	12	4	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	12
																						19
June 21.	Com. gurnard,	.	.	3	3	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
6-35 p.m.	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	
to	Dragonet,	.	.	.	1	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
8-35 p.m.	Haddock,	.	.	.	1	1	1	.	1	5	3	3	.	.	.	2	.	.	.	.	.	1
	Whiting,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Long rough dab,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Plaice,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	
	Lemon sole,	.	2	8	1	1	.	.	1	2	.	2	1	3	.	.	.	.	.	.	.	2
	Common dab,	13	61	13	9	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
Station XII.																						15
1900.																						
April 23.	Com. gurnard,	.	1	1	.	.	1	.	6	2	1	.	.	.	.	.	.	.	.	.	.	1
2-12 p.m.	Cat-fish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
to	Cod,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	
4-12 p.m.	Haddock,	.	.	.	2	.	.	3	1	4	.	.	.	.	.	.	1	.	.	.	.	1
	Whiting,	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Brill,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	
	Plaice,	.	.	.	.	.	.	.	.	.	1	3	2	2	.	1	.	.	.	.	.	
	Lemon sole,	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	
	Common dab,	7	20	9	4	1	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	4
																						8
May 30.	Com. gurnard,	.	.	8	5	18	8	5	2	.	3	.	.	.	.	.	.	.	.	.	.	4
7-25 p.m.	Pogge,	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
to	Dragonet,	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
9-25 p.m.	Cod,	.	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Haddock,	.	.	.	1	1	.	2	.	3	2	1	1	.	.	.	.	.	.	.	.	1
	Whiting,	.	.	.	.	.	.	2	1	1	1	.	.	.	.	.	.	.	.	.	.	
	Long rough dab,	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Brill,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	
	Plaice,	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	
	Lemon sole,	.	1	9	5	3	3	1	.	.	5	.	1	1	.	.	.	.	.	.	.	2
	Common dab,	22	84	45	12	7	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	17
																						27
June 21.	Com. gurnard,	.	.	4	1	19	8	5	.	.	.	.	.	.	.	.	.	.	.	.	.	3
2-45 p.m.	Dragonet,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
to	Cod,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	
5-10 p.m.	Haddock,	.	.	.	.	1	.	.	.	3	1	.	2	.	.	.	.	.	.	.	.	
	Whiting,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Long rough dab,	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Turbot,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Plaice,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	
	Lemon sole,	.	.	4	4	1	1	.	.	.	.	.	.	1	.	1	.	.	.	.	.	1
	Common dab,	9	42	23	8	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8
	Solenette,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	
																						14

* 3 inches. † 38 inches. ‡ 27 inches.

TABLE C.—Record of Observations made on Board the "Garland" during 1900

A. FISH CAUGHT Moray Firth—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																		Tc
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
Station XIII.																						
1900.	Com. gurnard,	.	.	6	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	
	Dragonet,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
April 24.	Haddock,	.	.	.	7	4	.	.	2	3	1	1	.	.	.	.	.	.	.	.	.	
11-20 a.m.	Whiting,	.	.	.	.	.	1	2	1	.	.	.	.	.	.	.	.	.	.	.	.	
to	Long rough dab,	.	1	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
11-40 a.m.	Plaice,	.	.	.	.	.	.	.	.	.	1	2	.	.	.	.	.	.	.	.	.	
and	Lemon sole,	.	.	.	3	.	.	1	1	1	.	.	.	.	1	.	.	.	.	.	.	
0-10 p.m.	Common dab,	7	10	10	5	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	
to																						
1-50 p.m.																						
May 31.	Com. gurnard,	.	.	6	2	2	2	.	2	.	.	.	.	.	.	.	.	.	.	.	.	
11-5 a.m.	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	
to	Dragonet,	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	
1-5 p.m.	Haddock,	.	.	.	.	1	.	.	2	4	1	1	1	.	.	.	.	.	.	.	.	
	Whiting,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Long rough dab,	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Plaice,	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	
	Lemon sole,	.	.	3	6	.	.	1	.	.	2	2	1	.	.	.	.	.	.	.	.	
	Common dab,	6	40	10	5	2	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	
June 22.	Com. gurnard,	.	.	5	7	7	7	6	.	.	.	.	.	.	.	.	.	.	.	.	.	
8-20 a.m.	Cat-fish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
to	Cod,	.	.	.	.	2	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	
10-20 a.m.	Haddock,	.	.	.	.	1	.	.	.	4	1	1	.	.	.	.	.	.	.	.	.	
	Plaice,	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	2	.	
	Lemon sole,	.	.	3	2	4	.	.	1	.	.	2	1	2	.	1	.	.	.	.	.	
	Common dab,	1	17	9	3	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Grey skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	
Station XIV.																						
1900.																						
May 31.	Com. gurnard,	.	.	11	29	26	11	3	2	.	.	.	.	.	.	.	.	.	.	.	.	
5-5 p.m.	Dragonet,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
to	Haddock,	.	.	.	16	24	4	1	5	4	1	.	1	.	.	.	.	.	.	.	.	
7-5 p.m.	Brassie,	.	2	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Whiting,	.	.	.	.	1	1	2	3	.	.	.	.	.	.	.	.	.	.	.	.	
	Long rough dab,	2	8	10	9	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Sail-fluke,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	
	Plaice,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	
	Lemon sole,	.	1	4	4	7	1	2	5	5	4	1	4	2	2	.	.	.	.	.	.	
	Common dab,	.	14	5	1	2	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	
June 21.	Com. gurnard,	.	5	30	28	22	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
0-30 p.m.	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
to	Haddock,	.	.	.	.	.	3	1	1	1	.	.	.	.	.	.	.	.	.	.	.	
2-10 p.m.	Whiting,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Long rough dab,	.	4	11	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Lemon sole,	.	2	5	4	8	1	1	2	7	3	4	.	1	1	.	.	.	.	.	.	
	Common dab,	3	24	9	4	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Grey skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	
	Cuckoo ray,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	

* 43 inches. † 27 inches. ‡ 38 inches. § Two 37, one over 38 inches.

BLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE "GARLAND" DURING 1900.

A. FISH CAUGHT—MORAY FIRTH—*continued.*

n, and	Kind of Fish.	Size in Inches. 4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	Total.
m																						
	Com. gurnard,	.	.	7	8	4	3	2	.	.	.	.	.	1	.	.	.	.	.	.	.	25
	Dragonet,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
0.	Haddock,	.	.	.	1	2	.	.	.	1	1	.	.	1	.	.	.	.	.	.	.	6
.m.	Whiting,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Long rough dab,	.	10	5	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	19
.m.	Sail-fluke,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Plaice,	.	.	.	.	.	.	.	.	.	1	1	1	.	.	.	1	.	.	.	.	4
	Lemon sole,	.	1	.	2	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	5
	Common dab,	9	30	21	6	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	70
																						132
22.	Com. gurnard,	1	2	16	12	16	2	5	2	1	1	.	.	.	.	.	.	.	.	.	.	58
.m.	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*2
	Dragonet,	.	.	2	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
.m.	Haddock,	.	.	.	.	.	.	.	1	1	.	.	.	1	.	.	.	.	.	.	.	3
	Long rough dab,	.	6	10	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	19
	Turbot,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1
	Plaice,	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	2
	Lemon sole,	.	1	4	3	3	.	1	.	1	.	.	.	.	.	1	.	.	.	.	.	14
on	Common dab,	41	78	30	10	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	165
L																						268
).																						
24.	Com. gurnard,	.	4	10	4	5	7	5	.	1	.	.	.	.	.	.	.	.	.	.	.	36
.m.	Angler,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	†3
	Dragonet,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
.m.	Haddock,	.	.	3	8	.	.	3	5	2	2	.	2	.	.	.	.	.	.	.	.	25
	Brassie,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Whiting,	.	.	.	.	4	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	6
	Hake,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
	Long rough dab,	1	15	19	7	2	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	44
	Lemon sole,	.	1	3	.	.	1	.	.	1	1	.	1	.	1	.	.	.	.	.	.	9
	Witch sole,	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	2
	Common dab,	17	17	19	9	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	66
	Starry-ray,	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	1	.	.	.	‡4
																						198
31.	Com. gurnard,	1	3	10	3	3	3	.	.	1	1	.	.	.	.	.	.	.	.	.	.	25
.m.	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	2	.	3
	Cat-fish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	§1
m.	Dragonet,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Haddock,	.	.	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Brassie,	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Whiting,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Hake,	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1
	Long rough dab,	.	22	38	20	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	80
	Plaice,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	2
	Lemon sole,	.	1	7	5	1	1	.	.	.	1	1	3	2	1	.	.	.	.	.	.	23
	Common dab,	11	30	22	4	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	69
	Starry-ray,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
																						212
22.	Com. gurnard,	.	.	7	5	4	4	1	5	1	.	2	.	.	.	.	.	.	1	.	.	29
.m.	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	‖6
	Cat-fish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	¶2
.m.	Cod,	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	1	.	2	1	6
	Haddock,	.	.	.	.	6	.	2	.	1	1	.	3	.	.	.	1	.	.	.	.	14
	Brassie,	1	1	16	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	23
	Norway Pout,	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Whiting,	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	2
	Ling,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
	Long rough dab,	.	5	10	6	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	24
	Plaice,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1
	Lemon sole,	.	.	1	2	3	1	1	1	3	2	.	.	.	.	1	.	.	.	.	.	15
	Witch sole,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Common dab,	.	5	10	7	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**24
																						152

* One 26, one 32 inches. † One 26½, one 36 inches. ‡ One at 1½ inches. § 36 inches.
‖ Two 26, one 32, one 44 inches. ¶ One 35, one 36 inches. ** One 3 inches.

D

TABLE C.—Record of Observations made on Board the "Garland" during 19(

A. FISH CAUGHT (Shrimp Trawl)—Moray Firth—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																		
		1 +	2 +	3 +	4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +
Station V.																				
1900.																				
	Com. gurnard,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dec. 5.	Pogge,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
2-10 p.m.	Cod,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
to	Whiting,	.	.	3	21	14	4	2	.	1	.	.	.	.	.	.	.	.	.	.	.
3-10 p.m.	Long rough dab,	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Common dab,	.	.	.	6	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Solenette,	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Station VII.‡																				
1900.																				
Jan. 24.	Com. gurnard,	.	.	1	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
1-0 p.m.	Goby, sp.,	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
to	Dragonet,	.	.	7	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
2-0 p.m.	Cod,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Whiting,	.	.	1	17	11	5	.	1	.	.	.	.	.	.	.	.	.	.	.	.
	Hake,	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Long rough dab,	.	8	4	4	16	14	4	.	.	.	.	.	.	.	.	.	.	.	.	.
	Topknot,	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
	Lemon sole,	.	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
	Witch sole,	.	.	.	.	.	.	.	2	2	1	.	.	.	.	.	.	.	.	.	.
	Common dab,	.	.	1	7	15	15	10	3	.	.	.	.	.	.	.	.	.	.	.	.
	Lumpenus,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
Feb. 12.	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
4-0 p.m.	Cod,	.	.	1	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
to	Haddock,	.	.	.	.	.	.	.	.	.	.	3	.	1	.	.	.	.	.	.	.
5-0 p.m.	Whiting,	.	.	.	4	10	6	1	1	.	.	.	.	.	.	.	.	.	.	.	.
	Long rough dab,	.	.	.	8	16	5	6	.	.	.	.	.	.	.	.	.	.	.	.	.
	Witch sole,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.
	Common dab,	.	.	.	3	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Lumpenus,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
June 12.	Com. gurnard,	.	.	.	.	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.
4-0 p.m.	Witch sole,	.	.	.	.	2	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
to	Common dab,	.	.	.	1	2	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.
5-0 p.m.																					
Dec. 19.	Haddock,	.	.	.	.	.	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.
0-30 p.m.	Poor-cod,	.	.	3	3	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
to	Whiting,	.	.	1	8	5	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.
1-30 p.m.	Long rough dab,	.	.	.	1	7	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Lemon sole,	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
	Common dab,	.	.	.	8	12	9	3	.	.	.	.	.	.	.	.	.	.	.	.	.
Station IX.																				
1900.																				
Jan. 31.	Com. gurnard,	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.
9-38 a.m.	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.
to	Dragonet,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
10-38 a.m.	Brassie,	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Whiting,	.	.	.	1	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.
	Long rough dab,	.	2	.	3	6	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Plaice,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Lemon sole,	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.
	Common dab,	.	.	.	12	12	7	.	4	.	.	.	.	.	.	.	.	.	.	.	.

* 35 inches. † One 21, one 23 inches. ‡ 22 inches.

BLE C.—Record of Observations made on Board the "Garland" during 1900.

A. FISH CAUGHT (Shrimp Trawl)—Moray Firth—*continued.*

on, and e wl n.	Kind of Fish.	Size in Inches. 1 +	2 +	3 +	4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	Total.
ion .).																						
9. .m.).m.	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*1
	Whiting,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Long rough dab,	.	5	1	.	3	4	3	.	.	.	.	.	.	.	.	.	.	.	.	.	16
	Lemon sole,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	2
	Witch sole,	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	2
	Common dab,	.	.	.	2	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
																						27
20. .m. .m.	Haddock,	.	.	.	.	.	1	3	.	.	.	.	1	.	.	.	.	.	.	.	.	5
	Whiting,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
	Long rough dab,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Common dab,	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	2
																						9
14.).m.).m.	Com. gurnard,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
	Pogge,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*1
	Dragonet,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Long rough dab,	.	.	.	1	1	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	5
	Witch sole,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
	Common dab,	.	1	21	14	19	6	1	1	.	.	.	.	.	.	.	.	.	.	.	.	63
	Tangle-fish,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
																						74
18. oon)).m.	Haddock,	.	.	.	.	.	4	.	.	1	.	.	.	.	.	.	.	.	.	.	.	5
	Long rough dab,	.	.	.	2	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
	Lemon sole,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1
	Common dab,	.	.	.	2	5	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8
	Pipe-fish,	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1
ion I.																						21
)0.																						
1 23. p.m.) p.m.	Pogge,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Dragonet,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Haddock,	.	.	.	.	.	.	.	.	.	.	.	1	.	3	.	.	.	.	.	.	4
	Sand-eel,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
																						7
30. p.m.)).m.	Long rough dab,	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Lemon sole,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Common dab,	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
																						8
22. a.m.) a.m.	Pogge,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Dragonet,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Cod,	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Haddock,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Lemon sole,	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1
	Common dab,	.	2	3	7	21	3	1	.	1	.	.	.	.	.	.	.	.	.	.	.	38
	Solenette,	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
																						47

* 22 inches. † 30 inches.

TABLE C.—Record of Observations made on Board the "Garland" during 1900.

A. FISH CAUGHT (Shrimp Trawl)—Moray Firth—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																			Total
		1 +	2 +	3 +	4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	
Station XIII.																					
1900.																					
	Angler,																				*1
April 24.	Long rough dab,		1																		1
2-15 p.m.	Lemon sole,						1														1
to	Common dab,				2	2															4
3-15 p.m.	Solenette,			1																	1
																					8
June 22.	Commen dab,			1	5	12	3	3	1												25
10-40 a.m.	Solenette,			1																	1
to																					26
11-40 a.m.																					
Station XVI.																					
1900.																					
April 24.	Whiting,									1											1
8-35 a.m.	Long rough dab,		7			3	7														17
to	Common dab,					1	3														4
9-35 a.m.																					22
May 31.	Ling,																				†1
8-30 a.m.	Long rough dab,			2		5	1														8
to	Common dab,						2														2
9-30 a.m.	Painted sea-adder,										1					1					2
																					13
June 22.	Com. gurnard,							1	1		1										3
4-10 p.m.	Dragonet,			1																	1
to	Haddock,												1								1
5-10 p.m.	Hake,																	1			1
	Long rough dab,			2	2	4	3	1	1												13
	Lemon sole,				3	1									1						5
	Common dab,		2	18	3	11	7	3	1												45
	Grey skate																				‡1
																					70

* 35 inches. † 40 inches. ‡ 21 inches.

TABLE C.—Record of Observations made on Board the "Garland" during 1900.

B—PHYSICAL OBSERVATIONS—Moray Firth.

Station, Date, and Hour.	End of Station.	Temperature. Air. Dry Bulb.	Temperature. Water. Surface.	Temperature. Water. Bottom.	Depth in faths.	Wind. Direction.	Wind. Force.	Weather.	Sea.	Tide.	Barometer.	Transparency. Fathoms.
Station I.												
1900. Jan. 16. 12.21 p.m.	E.	40·64	41·9	42·5	8½	W.S.W.	4	Fine.	Slight.	5½ h. fl.	29·28	3
2.18 p.m.	W.	41·00	41·2	42·6	8	,,	4	,,	Choppy.	1¼ h. ebb.	29·30	2½
Feb. 8. 1.45 p.m	W	31·00	40·0	39·0	7	S.W.	4	Fine, clear.	Slight.	¾ h. fl.	29·88	3
3.27 p.m.	E	32·00	40·0	41·0	8	,,	3	Fine.	Calm.	2½ ,,	29·87	5
April 18. 12.35 p.m.	W.	51·08	43·2	43·9	7½	W.S.W.	2	Cloudy.	S.W. swell.	4¾ ,,	30·18	2
2.35 p.m.	E.	49·28	43·9	43·0	9½	N.W.	3	Cloudy, dull	N.W. swell.	45 m. ebb.	30·20	2
May 11. 11.0 a.m.	W.	45·68	46·2	45·0	7½	E.	3	Cloudy.	E. swell.	1 h. ebb.	30·10	3½
1.15 p.m.	E.	44·60	45·4	44·4	8	,,	3	,,	,,	3¼ ,,	,,	3
June 6. 12.15 p.m	W	48·20	51·1	48·0	8	,,	2	Overcast.	Slight, with E. swell.	¼ h. fl.	29·95	6
2.30 p.m.	E.	51·26	50·9	48·2	8	,,	3	Cl'dy, haze.	Moderate.	2½ ,,	29·92	8
Dec. 12. 11.55 a.m.	E.	50·36	46·5	46·8	8	W.	2	Fine, clear.	Slight.	2 ,,	29·70	3½
2.20 p.m	W.	51·08	47 0	47·5	7	S.W.	5	Cloudy.	Choppy.	4h. 15m. fl.	29·68	3½
Station II.												
Jan. 17. 8.35 a.m.	W.	36·50	41·9	44·4	10	S.W.	3	Fine.	Calm.	1½ h. fl.	29·42	2
10.40 a.m.	E.	39·20	41·3	42·8	12	S.	3	,,	,,	3½ h. ,,	29·39	3
Feb. 7. 8.50 a.m.	W	32·3	40·0	42·3	11	N.W.	5	Fine.	Slight.	3 h. ebb.	29·76	2
10.47 a.m.	E	32·54	39·0	43·7	17	W.S.W.	6	O'rcast, passing snow shower.	Moderate.	5 h. ,,	29·72	3
April 9. 11.30 a.m.	W.	49·64	42·5	41·6	12	W.	3	Fine, cloudy.	Slight.	3½ h. ebb.	29·56	2½
1.50 p.m.	E.	48·20	43·1	42·5	14	W. by S.	4	—	,,	5½ h. ,,	29·55	2½
May 7. 12.10 p.m.	E.	49·10	47·3	48·8 48·9	18 9	N.N.E.	2	Overcast, hazy.	Calm. N. E. swell.	Low water	29 48	2¾
2.28 p.m.	W.	48·56	47·2	44·7	9	,,	2	Overcast.	,,	2h. 18m. fl.	29 49	2¾
June 5. 10.2 a m.	E.	48·74	51·9	45·9	16	N.E.	Light.	Overcast, hazy.	Slight, E. swell.	4h. 40 m. ebb.	30·10	5
12.18 p.m.		53·60	50·3	46·0	13	,,	2	Fine, haze.	,,	56 m. fl.	30·07	4
Dec. 3. 11.30 a.m.	W.	41·00	44·8	49·0	12	S.W.	2	Cloudy.	Slight.	2h. 27m. ebb.	29·61	2
1.45 p.m.	E	43·52	44·2	49·0	10	—	—	Fine, clear.	Calm.	4h. 43m. ebb.	29·58	2

TABLE C.—Record of Observations made on Board the "Garland" during 1900.

B. PHYSICAL OBSERVATIONS.—Moray Firth—*continued.*

Station, Date, and Hour.	End of Station.	Temperature.				Wind.		Weather.	Sea.	Tide.	Barometer.	Transparency. Fathoms.
		Air.	Water.									
		Dry Bulb.	Surface.	Bottom.	Depth in faths.	Direction.	Force.					
Station III.												
1900. Jan. 17. 11.33 a.m.	E.	38·84	42·0	43·1	10	S.S.W.	2	Fine.	Calm.	4½ h. fl.	29·38	3
12.45 p m.	W.	38·84	41·2	43·0	8	S.S.E.	1	,,	Smooth.	5½ ,,	29·34	1¾
Feb. 5. 3.15 p.m.	E.	39·56	41·4	42·0	10	N.	3	Fine, clear.	Ripple.	5½ ,,	29·78	2
4.35 p.m.	W.	38·84	40·0	41·0	8	N.N.E.	4	Snowstorm.	,,	½ h. ebb.	29·79	2
April 12. 1.45 p.m.	W.	46·58	43·0	42·1	9	W.S.W.	4	Overcast, continuous rain.	Slight.	3 ,,	29·22	1½
2.58 p.m.	E.	47·48	43·0	42·1 42·0	22½ 11½	,,	6	,, ,,	,,	4h. 13m. ebb.	29·16	1¾
May 7 9.30 a.m.	W.	50·00	47·5	49·9	7	E.N.E.	2	Cloudy haze.	,,	3½ h. ebb.	29·50	2
10.50 a.m.	E.	51·62	47·9	45·1	8½	N.E.	2	Hazy.	,,	4h. 50m. ebb.	29·48	2½
June 5. 2.8 p.m.	E.	47·84	52·3	49·2	10	E.S.E.	1	Overcast, hazy.	Calm.	3h. 42m. fl.	30·15	2½
3.50 p.m.	W.	50·00	53·0	50·5	13	,,	1	Overcast.	,,	5 h. fl.	30·12	3
Nov. 30. 11.55 a.m.	E.	44·24	44·8	47·0	8	E.	2	,,	Slight.	near low water.	29·86	1¾
1.40 p.m.	W.	44·24	44·3	46·2	7½	,,	2	,,	,,	¾ h. fl.	29·87	1¼
Station IV. 1900. Jan. 19. 8.52 a.m.	S.	43·34	43·0	43·9	9	S.W.	4	Overcast, showery.	Calm, S.W. swell.	Low water.	29·48	2
10.48 a.m.	N.	44·24	43·4	43·4	13	,,	5	Rain.	Choppy.	2 h. flood.	29·39	3
Feb. 13. 10.45 a m.	S.	38·30	39·3	38·8	9½	,,	3	Fine, clear.	Slight, N. E. swell.	4½ ,,	29·38	3
12.35 p.m.	N.	41·36	41·0	40·3	13	,,	2	,,	Calm.	½ h. ebb.	29·42	3
April 10. 10.50 a.m.	N.	40·82	41·9	41·9	11	N.W.	6	Cloudy, passing show'rs of hail and sleet.	Rough.	2 ,,	29·40	2½
p.m.	S.	41·72	42·0	43·0	9	,,	7	,, ,,	,,	4½ ,,	29·42	2
y 8. p.m.	S.	54·50	47·9	47·1	9	E.S.E.	1	Fine, haze.	Calm.	2h. 10m. fl.	29·79	3½
p.m.	N.	51·08	47·5	44·7	13	N.	3	Clou y, fog.	Slight.	4½ h. fl.	29·80	4
June 11. 2.0 p.m.	N.	58·64	51·9	50·6	10	E.	1	Fine, hazy.	Calm, E. swell.	3h. 3m. ebb.	29·88	7
4.25 p m.	S.	59·00	53·5	51·00	7	E.N.E.	3	Cloudy.	Slight.	5h. 25m. ebb.	28·89	4½
Dec. 6. 9.35 a.m.	N.	40·10	44·9	46·3	10	,,	3	Overcast, rain.	Moderate, E. swell.	2 h. fl.	29·52	3
12.20 p.m.	S.	41·90	44·3	44·9	7	,,	4	,,	,,	4¾ ,,	29·52	3

TABLE C.—Record of Observations made on Board the "Garland" during 1900.

B. PHYSICAL OBSERVATIONS—Moray Firth—*continued.*

Station, Date, and Hour.	End of Station.	Temperature. Air. Dry Bulb.	Temperature. Water. Surface.	Temperature. Water. Bottom.	Temperature. Water. Depth in faths.	Wind. Direction.	Wind. Force.	Weather.	Sea.	Tide.	Barometer.	Transparency. Fathoms.
Station V. 1900. Jan. 19. 11.5 a.m.	N.E.	44·60	43·2	43·1	17	S.W.	5	Overcast, showery.	Moderate.	2½ h. fl.	29·38	4
12.45 p.m.	S.W.	40·64	43·0	42·0	13	W.N.W.	4	,, ,,	Choppy.	4h. 10m. fl.	29·40	4
Feb. 13. 12.49 p.m.	N.E.	41·36	40·5	44·0	16	S.W.	2	Fine, clear.	Calm.	½ h. ebb.	29·42	3
2.30 p.m.	S.W.	40·82	39·9	39·8	13	,,	4	Fine.	Slight.	2h. 10m. ,,	29·42	3
April 11. 7.30 a.m.	N.E.	38·84	42·0	42·0 42·9	17 8½	S.S.E.	3	Overcast, continuous rain.	,,	3½ h. flow.	29·18	2
9.35 a.	S.W.	39·20	42·8	42 0	10¼	Variable	0	,, ,,	Calm.	5½ h. ,,	29·13	1½
May 8. 12.45 p.m.	N.E.	53·24	49·5	44·0	15	..	0	Fine, hazy.	Quite calm.	5h. 45m. ebb.	29·79	4
3.0 p.m.	S.W.	55·22	46·5	47·1	7	E.S.E.	0	Fine, haze	Calm.	2 h. fl.	29·79	3½
June 11. 11.20 a.m.	S.W.	58·64	53·0	49·6	10	E.	1	,,	Slight, easterly swell.	33m. ebb.	29·86	½
1.40 p.m.	N.E.	57·56	51·1	49·1	15	,,	1	Fine, slight haze.	Easterly swell.	2h. 43m. ebb.	29·88	8½
Dec. 5. 11.42 a.m.	S.W.	39·38	43·9	47·8	9¾	N.N.W.	1	Cloudy, fine.	Calm.	1 h. ebb.	29·50	3
2.0 p.m.	N.E.	41·36	43·9	48·0	15	E.	2	Overcast showery.	Slight E. swell.	2½ h. ,,	29·48	2½
Station VI. 1900. Jan. 19. 12.55 p.m.	W.	40·64	43·0	43·1	11	W.N.W.	4	Cloudy.	Choppy.	4h. 20m. fl.	29·42	3
2.30 p.m.	E.	41·36	43·2	43·9	19	S.W.	5	Fine, clear.	Slight.	Near high water.	29·41	4
Feb. 13. 2.45 p.m.	W.	39·74	39·0	40·2	10	,,	4	Fine.	,,	2½ h. ebb.	29·43	3
4.30 p.m.	E.	39·74	40·9	40·5	16	.	4	Fine, clear.	,,	4h. 10m. ,,	29·45	4
April 11. 9.55 a.m.	W.	39·92	42·5	42·0	7	Variable	0	Overcast.	Calm.	Near high water.	29·13	1½
11.50 a.m.	E.	43·70	43·0	42·7	18	N.W.	1	Overcast, showery.	,,	1h. 40m. ebb.	29·15	1¾
May 8. 10.5 a.m.	W.	50·90	47·5	46·4	7	E.	Light.	Fine, haze.	Quite calm.	3 h. ebb.	29·78	2½
12 noon.	E.	55·04	48·3	43·9	15	..	0	,,	,,	5 h. ,,	29.79	5
June 11. 5.25 p.m.	E.	57·92	53·8	52·3	15	E.N.E.	5	Fine, slight haze.	Moderate.	28 m. fl.	29·89	5
7.15 p.m.	W.	57·02	53·0	52·2		,,	5	Cloudy.	,,	2h. 18m. fl.	29·91	3½
Dec. 5. 9. 50 a.m.	E.	39·92	45·3	48·2	16	N N.W	1	Fine, cloudy.	Calm.	5h. 9m. ,,	29·48	2
11.33 a.m.	W.	39·20	43·8	47·6	7	.	1	,, ,,	,,	50m. ebb.	29·50	3

TABLE C.—Record of Observations made on Board the "Garland" during 1900.

B. PHYSICAL OBSERVATIONS.—Moray Firth—*continued.*

Station, Date, and Hour.	End of Station.	Temperature. Air. Dry Bulb.	Temperature. Water. Surface.	Temperature. Water. Bottom.	Depth in faths.	Wind. Direction.	Wind. Force.	Weather.	Sea.	Tide.	Barometer.	Transparency. Fathoms.
Station VII. 1900. Jan. 24.												
11.10 a.m.	W.	45·14	42·7	43·0 43·1	24	S.W.	4	Cloudy.	Slight.	Nearly low water.	29·40	2½
12.53 p.m.	E.	44·42	43·0	44·0 43·4	31	,,	3	Overcast, rain.	,,	1 h.40 m.fl.	29·38	3½
Feb. 12.												
2.12 p.m.	W.	35·96	41·5	41·7 41·6	24 12	S.S.W.	3	Fine, clear.	Slight, N.E. well.	3¼ h. ebb.	29·26	5
3.55 p.m.	E.	35·60	41·1	42·5 42·2	31 15½	,,	4	,,	,, ,,	5 h. ,,	,,	7
April 11.												
1.0 p.m.	W.	42·26	43·0	42·1 42·6	26½ 13¾	N.W.	1	Overcast, showery.	Slight.	2h.50m.eb.	29·15	2½
3.25 p.m.	E.	43·88	42·5	42·2 42·4	23 11½	,,	3	Cloudy, passing showers.	,,	4h.15m.eb.	29·18	3
May 23.												
10.30 a.m.	E.	54·68	52·1	45·0 45·5	30 15	W.	5	Cloudy.	Moderate.	3½ h. ebb.	29·34	5½
12.30 p.m.	W.	51·80	50·0	45·5	19	W.S.W.	5	,,	,,	5½ ,,	,,	5
June 12.												
9.0 a.m.	W.	55·04	51·0	46·1 47·7	25 12½	E.	1	Overcast, slight haze.	Calm, E. swell.	3h.43m.fl.	29·91	11
11.35 a.m.	E.	55·04	51·2	45·8 46·0	33 16½	,,	1	Overcast.	Calm.	8 m. ebb.	29·92	11
Station VIII. 1900. Jan. 31.												
11.5 a.m.	N.	40·64	43·8	44·0 43·9	36 18	N.	3	Cloudy.	Slight, with N.E. swell.	4h.35m.fl.	30·05	6
12.50 p.m.	S.	40·10	43·0	44·0 43·9	36 18	N.E.	3	,,	,, ,,	High water	30·02	5
Feb. 9.												
2.25 p.m.	S.	35·96	43·0	42·8 42·9	31 15½	N.N.E.	3	Fine.	N.E.swell.	Low water	29·88	7
4.0 p.m.	N.	34·16	42·9	43.0 42·9	29 14½	Nort 'ly	2	Fine, clear.	Calm, N.E.swell.	1¾ h. fl.	,,	7
April 20.												
5.25 a.m.	S.	47·8	43·5	42·8 43·2	34 17	W.	3	,,	Calm, W. swell.	2h. 24m. ebb.	30·35	4½
7.55 a.m.	W.	50 00	43·7	42·8 42 9	30 15	W.S.W.	4	,,	Choppy.	5h. 5m. ebb.	30·34	5
June 12.												
1.37 p.m	N	55·40	51·1	46·0 46·3	31 15½	E.N.E.	1	Fine, haze.	Easterly swell.	2h. 20m. ebb.	29·92	9
4.0 p.m.	S.	59·90	51·9	45·7 46·0	33 16½	,,	Ligh .	,,	Smooth.	4h. 48m. ebb.	29·93	17
Station IX. 1900. Jan. 31.												
7.42 a.m.	N.	38·48	43·2	43·7 43·3	34 17	N.	1	Overcast.	Calm. heavy N.E. swell	1 h. flood.	30·08	5
9.35 a.m.	S.	39·56	43·0	44·0 43·7	36 18	N.N.W.	2	Cloudy.	,, ,,	3 h. flood.	30·06	5
Feb. 9.												
10.58 a.m.	S.	31·00	43·0	43·0 42·9	43 21½	W.	3	Fine, clear.	Calm, N.E. swell	3 h. ebb.	29·90	6½
12.50 p.m.	N	33·80	42·9	42·9 42·9	36 18	N.E.	1	,,	,, ,,	5 h. ebb.	,,	8

TABLE C.—Record of Observations made on Board the "Garland" during 1900.

B. PHYSICAL OBSERVATIONS.—Moray Firth—*continued.*

Station, Date, and Hour.	End of Station.	Temperature. Air. Dry Bulb.	Temperature. Water. Surface.	Temperature. Water. Bottom.	Temperature. Water. Depth in faths.	Wind. Direction.	Wind. Force.	Weather.	Sea.	Tide.	Barometer.	Transparency. Fathoms.
Station IX. 1900. April 20.												
8.35 a.m.	N.	50·54	43·7	43·0 43·1	29 14½	W.S.W.	3	Fine, clear.	Choppy.	5¾h. ebb.	30·33	6
10.55 a.m.	S.	56·30	44·0	42·6 43·0	27 13½	,,	1	,,	Calm.	1½h. fl.	30·34	5
June 14.												
2.20 p.m.	S.	59·72	52·2	45·8 46·9	35 17½	E.	1	,,	Calm, E. swell.	1h. 40m. ebb.	29·97	9½
4.45 p.m.	N.	59·90	53·3	46·1 46·5	30 15	S.E.	1	,,	,, ,,	4h ,,	30·00	8
Station X. 1900. Jan. 31.												
2.5 p.m.	S.E.	39·02	43·0	44·0	16	N.N.E.	4	Overcast, passing snowstorm	Slight, N.E.swell.	1¼h. ebb.	30·00	5
3 25 p.m.	N.W.	39·74	42·3	42·5 43·0	20 10	,,	3	Cloudy.	,, ,,	2½h. ,,	29·98	5
Feb. 9.												
8.40 a.m.	S.E.	29·0	42·6	42·7	15½	S.W.	3	Fine.	,, ,,	40m. ebb.	29·91	7
10.23 a.m.	N.W.	29·0	42·8	42·9	19	W.	3	,,	,, ,,	2h.25m. ,,	29·90	6½
April 19												
12.20 p.m.	S.E.	54·68	43·5	43·0	18½	W.N.W.	3	Cloudy, slight haze.	Calm.	3h.27m.fl.	30·35	3½
3.15 p.m.	N.W.	51·26	43·7	42·8 43·0	25 12½	W.	4	Fine, slight haze.	W. swell.	22m. ebb.	30·35	5
June 14.												
10.35 a.m.	S.E.	48·92	51·7	46·5 47·2	17 8½	W.N.W.	2	Cloudy.	Slight.	4¼h. fl.	29·94	7½
1.10 p.m.	N.W.	60·80	53·8	45·9 46·6	33 16½	N. by E.	Light.	Fine,cloudy	Calm.	½h. ebb.	29·97	9½
Dec. 14.												
8.12 a.m.	S.E.	49·28	47·4	48·0	17	S.W.	5	Cloudy.	Choppy.	3h. ,,	29·64	3½
10.30 a.m.	N.W	51·08	48·1	48·1	27	S.S.W.	6	,,	Rough.	5h. 13m. ebb.	29·62	4
Station XI. 1900. April 23.												
9.50 a m.	W.	46·78	44·0	43·2 43·7	21 10½	Light, variable airs.	0	Fog.	Heavy, S.E. swell.	4h. 10m. ebb.	30·12	5½
12.5 p.m.	E.	48·20	44·0	43·3 43·6	23 11½	S.E.	Light.	,,	S.E. swell.	25m. fl.	30·11	6
May 30.												
3.35 p.m.	W.	49·46	47·1	46·5 46·6	21 10½	E.	1	Moderately clear.	Calm, E. swell.	3¼h. ebb.	30·36	7
5.55 p.m.	E.	49·10	46·1	47·2 46·3	23 11½	,,	2	Cloudy.	Slight.	5½h. ,,	30·36	7
June 21.												
6.27 p.m.	E.	56·30	52·1	47·9 48·0	23 11½	N.W.	Light.	Cloudy, fine.	Smooth.	25m. ,,	29·68	6
8.50 p.m.	W.	54·32	53·8	47·9 48·3	25½ 12¾	W.N.W.	,,	Cloudy, passing showers.	Calm.	2h. 48m. ebb.	29·68	8

TABLE B.—Record of Observations made on Board the "Garland" during 1900.

B. PHYSICAL OBSERVATIONS.—Moray Firth—*continued.*

Station, Date, and Hour.	End of Station.	Temperature.				Wind.		Weather.	Sea.	Tide.	Barometer.	Transparency. Fathoms.
		Air.	Water.									
		Dry Bulb.	Surface.	Bottom.	Depth in faths.	Direction.	Force.					
Station XII. 1900. April 23.												
2.5 p.m.	N.	47·84	44·1	43·2 43·4	25 12½	S.	Light.	Haze, overcast	Calm, S.E. swell.	2h. 25m. fl.	30·10	5½
4.25 p.m.	S.	47·48	45·3	43·2 43·8	24 12	Light, variable airs.	0	Overcast, haze.	,, ,,	4h. 45 m. fl.	30·10	4½
May 30.												
7.20 p.m.	.	50·00	46·1	46·5 46·5	21 10½	E.N.E.	2	Fine, cl'dy.	Slight.	¾h. fl.	30·36	7
9.40 p.m.	S.	46·58	47·0	46·1	22½	N.E.	Light.	Overcast.	E. swell.	3h. ,,	30·36	7
June 21.												
3.40 p.m.	N.	54·86	52·3	48·8 48·9	24 12	N.W.	1	Cloudy, passing showers	Calm, E. swell.	3h. 40m. fl.	29·67	7
6.0 p.m.	S.	57·20	53·0	47·8 47·9	24 12	Variable	Light.	Fine, cl'dy.	Smooth.	Near high water	29·68	7
Station XIII. 1900. April 24.												
10.10 a.m.	S.	46 04	44·0	43·3 43·4	29 14½	N.W.	1	Overcast.	Slight.	4h. 5m. ebb.	30·02	5½
2.5 p.m.	N.	45·68	43·9	43·4 43·5	28 14	,,	3	Cloudy.	Choppy.	Low water.	30·02	6
May 31.												
10.55 a.m.	S.	47·66	47·7	46·1 46·1	28 14	E.N.E.	1	Overcast.	Smooth.	3¾h. fl.	30·38	7
1.45 p.m.	N.	51·80	47·4	46·2 46·3	25 12½	,,	Light airs.	,,	,,	55m. ebb.	30·40	8
June 22.												
8.12 a.m.	S.	54·32	51·5	48·0 48·0	25 12½	Light airs.	0	Fog.	,,	1h. ,,	29·69	7
10.35 a.m.	N.	58·46	53·2	47·8 48·0	28½ 14½	S.	1	Cloudy, slight haze.	Quite smooth.	3h. 16m. ebb.	29·72	7
Station XIV. 1900. April 25.												
6.45 a.m.	N.	38·48	43·5	43·6 43·6	27 13½	N.	3	Cloudy.	Slight, heavy N. swell.	..	30·14	6
9.10 a.m.	S.	40·10	43·3	43·2 43·2	40 20	,,	4	,,	Heavy N.E. swell, cloudy.	..	3 ·15	6
May 31.												
5.0 p.m.	N.	49·10	47·7	48·2 46·7	26 13	E.S.E.	1	Overcast.	Calm.	4h. 10m. ebb.	30·40	7
7.20 p.m.	S.	47·84	48·3	46·2 46·2	36 18	,,	1	,,	,,	½h. fl.	30·41	6
June 21.												
12.25 a.m.	N.	53·24	55·03	48·6 49·0	25½ 12½	Variable	Light.	Heavy rain.	E. swell, calm.	20m. flood.	29·67	6½
2·50 p.m.	S.	54·50	52·9	47·2 48·0	41 20½	N.	,,	,,	,, ,,	2h. 50m. fl.	29·67	7
Station XV. 1900. May 30.												
11.35 a.m.	N.	52·88	46·2	46·0 46·0	33 16½	..	0	Cloudy.	Light, N.E. swe	5½h. fl.	30·36	
2.0 p.m	S.	58·28	46·9	49·9 46·1	28 14	E.	0	Fine, moderately clear.	Calm.	1½h. ebb.	30·36	5½
June 22.												
6.25 p.m.	S.	59·00	55·9	47·2 47·4	27 13¾	S.E.	0	Cloudy, fine.	Calm, E. swell.	5h. 10m. fl.	29·72	10
8.47 p.m.	N.	55·58	54·5	47·2 48·0	31 15½	E.	1	,,	,, ,,	1½h. ebb.	29·72	9

TABLE C.—Record of Observations made on Board the "Garland" during 1900.

B. PHYSICAL OBSERVATIONS—Moray Firth—*continued.*

Station. Date, and Hour.	End of Station.	Temperature. Air. Dry Bulb.	Temperature. Water. Surface.	Temperature. Water. Bottom.	Depth in faths.	Wind. Direction.	Wind. Force.	Weather.	Sea.	Tide.	Barometer.	Transparency. Fathoms.
Station XVII.												
1900. April 24. 6.0 a.m.	N.	46·04	45·0	43.1 43·7	30 15	N.N.W.	Light.	Overcast.	Slight.	5½h. fl.	30·06	5
8.25 a.m.	S.	46·04	45·0	43·0 43·3	41 20½	,,	1	Overcast, with fog.	,,	1h. 40m. ebb.	30·06	3½
May 31. 6.5 a.m.	N.	45·68	47·0	46·0 46·0	29 14½	N.E.	Light.	Hazy.	Calm.	5h. ebb.	30·36	7
8.25 a.m.	S.	47·30	47·6	45·5 45·8	35 17½	,,	,,	Overcast, haze.	,,	1h. 20m. fl.	30·37	8
June 22. 1.35 p.m.	N.	59·36	55·3	47·6 47·7	28 14	Light airs.	0	Cloudy, fine.	,,	18m. flood	29·73	9
4.0 p.m.	S.	59·36	55·8	47·0 47·2	39 19½	S.E.	1	,,	,,	2¾h. fl.	29·73	10

TABLE D.—SHOWING THE QUANTITIES OF FISH CAUGHT BY LINE IN 1900 WITHIN THE MORAY FIRTH (INSIDE A LINE BETWEEN DUNCANSBY HEAD AND RATTRAY POINT), AND THE NUMBER OF SHOTS OF THE BOATS BY WHICH THE FISH WERE CAUGHT.

WICK DISTRICT.

Months.	Number of Shots.		Cod.		Ling.		Torsk (Tusk).		Saithe (Coalfish).		Haddock.		Whiting.		Turbot.		Halibut.		Sole (Lemon Sole).		Flounder, Plaice, Brill.		Eel.		Skate.		Other kinds of White Fish.		Total of Line-caught Fish.	
	Large Boats.	Small Boats.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average	Cwt	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.
Jan.	242	239	3,043	6·326	208	0·432	.	.	2,040	·4241	80	0·166	.	.	4	0·008	53	0·11	.	.	7	0·014	99	0·205	585	1·216	102	0·212	6,221	12·93
Feb.	296	188	1,926	3·979	212	0·438	3	0·006	430	0·888	51	0·105	.	.	.	.	32	0·066	.	.	29	0·06	46	0·095	244	0·504	63	0·13	3,036	6·272
March	85	205	1,705	5·879	456	1·572	.	.	113	0·389	42	0·144	.	.	.	.	35	0·12	.	.	56	0·193	26	0·089	322	1·11	47	0·162	2,802	9·662
April	78	266	962	2·796	355	1·031	.	.	108	0·313	11	0·032	.	.	.	.	39	0·113	.	.	31	0·09	9	0·026	149	0·433	34	0·098	1,698	4·936
May	22	292	520	1·656	56	0·178	.	.	295	0·939	.	.	.	.	.	.	1	0·003	.	.	11	0·035	.	.	.	.	70	0·222	953	3·035
June	16	160	504	2·806	.	.	.	.	410	2·329	31	0·176	.	.	.	.	2	0·011	.	.	.	.	.	.	.	.	26	0·147	973	5·528
July	200	174	504	1·347	62	0·165	.	.	608	1·625	41	0·109	.	.	.	.	2	0·005	.	.	44	0·117	.	.	.	.	14	0·037	1,275	3·409
Aug.	500	234	615	0·837	85	0.115	.	.	545	0·742	30	0·04	.	.	.	.	.	.	.	.	60	0·081	.	.	.	.	20	0·027	1,355	1·846
	82	312	377	0·956	30	0·076	.	.	253	0·642	189	0·479	.	.	.	.	.	.	.	.	55	0·139	.	.	.	.	21	0·053	925	2·347
Oct.	.	751	368	0·49	.	.	.	.	1,121	1·492	785	1·045	.	.	.	.	.	.	.	.	50	0·066	.	.	.	.	17	0·022	2,341	3·117
Nov.	.	505	305	0·603	48	0·095	.	.	200	0·396	476	0·942	.	.	.	.	.	.	.	.	44	0·087	.	.	.	.	9	0·017	1,082	2·142
Dec.	3	425	415	0·969	53	0·123	.	.	234	0·546	500	0·116	.	.	.	.	.	.	.	.	59	0·137	.	.	.	.	5	0·011	1,266	2·957
Totals,	1,524	3,751	11,244	2·131	1,565	0·296	3	0·0005	6,357	1·205	2,236	0·423	.	.	4	0·0007	164	0·031	.	.	446	0·084	180	0·034	1,300	0·246	428	0·081	23,927	4·535

TABLE D.—*continued.*—LYBSTER DISTRICT.

Months.	Number of Shots.		Cod.		Ling.		Torsk (Tusk).		Saithe (Coalfish).		Haddock.		Whiting.		Turbot.		Halibut		Sole (Lemon Sole).		Flounder, Plaice, Brill.		Eel.		Skate.		Other kinds of White Fish.		Total of Line-caught Fish.	
	Large Boats.	Small Boats.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.
Jan.	95	87	572	3·142	.		.	.	54	0·296	91	0·5	.	.	.	.	.	.	.	.	.	.	2	0·01	.	.	55	0·302	774	4·252
Feb.	68	49	282	2·41	.	.	.	.	20	0·17	35	0·299	.	.	.	.	.	.	.	.	.	.	.	.	.	.	35	0·299	372	3·179
March	32	74	355	3·349	.	.	.	.	68	0·641	39	0·367	.	.	.	.	5	0·047	.	.	.	.	.	.	.	.	40	0·377	507	4·783
April	.	45	62	1·37	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	0·08	66	1·466
May	2	91	93	1·	.	.	.	.	36	0·387	11	0·118	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8	0·086	148	1·591
June	11	96	116	1·084	.	.	.	.	59	0·551	56	0·523	.	.	.	.	.	.	.	.	.	.	.	.	.	.	35	0·327	266	2·485
July	610	42	109	0·167	.	.	.	.	136	0·208	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	33	0·05	278	0·426
Aug.	590	29	98	0·158	.	.	.	.	80	0·129	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	46	0·074	224	0·361
Sept.	149	49	92	0·464	.	.	.	.	97	0·489	.	.	.	.	.	.	.	.	.	.	.	.	10	0·05	.	.	32	0·16	231	1·16
Oct.	.	80	77	0·962	.	.	.	.	.	.	130	1·625	.	.	.	.	.	.	.	.	4	0·05	.	.	.	.	48	0·6	259	3·237
Nov.	.	36	37	1·027	.	.	.	.	.	.	75	2·083	.	.	.	.	.	.	.	.	.	.	.	.	.	.	13	0·361	125	3·472
Dec.	6	88	108	1·148	.	.	.	.	8	0·085	85	0·904	.	.	.	.	.	.	.	.	.	.	.	.	.	.	17	0·180	218	2·319
Totals,	1,563	766	2,001	0·869	.	.	.	.	558	0·242	522	0·226	.	.	.	.	5	0·002	.	.	4	0·001	12	0·005	.	.	366	0·158	3,468	1·506

TABLE D.—*continued.*—HELMSDALE DISTRICT.

Months.	Number of Shots.		Cod.		Ling.		Torsk (Tusk).		Saithe (Coalfish).		Haddock.		Whiting.		Turbot.		Halibut.		Sole (Lemon Sole).		Flounder, Plaice, Brill.		Eel.		Skate.		Other kinds of White Fish.		Total of Line-caught Fish.	
	Large Boats.	Small Boats.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.
Jan.	98	290	1,054	2·716	.	.	.	.	53	0·136	1,020	2·628	.	.	.	.	.	.	.	.	13	0·033	11	0·028	12	0·03	.	.	2,163	5·574
Feb.	81	157	712	2·991	10	0·042	.	.	9	0·037	432	1·815	1	0·004	.	.	.	.	.	.	57	0·239	5	0·02	10	0·04	.	.	1,236	5·193
March	67	230	762	2·565	12	0·04	.	.	38	0·127	293	·986	8	0·026	.	.	3	0·01	.	.	369	1·242	.	.	.	.	.	.	1,485	5·
April	.	242	185	0·764	.	.	.	.	6	0·024	96	·396	4	0·016	.	.	.	.	.	.	62	0·256	.	.	.	.	52	0·214	405	1·673
May	.	150	121	0·806	.	.	.	.	45	0·3	86	·573	.	.	.	.	.	.	.	.	14	0·093	.	.	.	.	34	0·226	300	2·
June	.	127	114	0·897	.	.	.	.	34	0·267	167	1·314	3	0·023	.	.	.	.	.	.	14	0·11	.	.	.	.	40	0·314	372	2·929
July	.	79	30	0·379	.	.	.	.	23	0·291	53	·67	.	.	.	.	.	.	.	.	33	0·417	5	0·063	.	.	20	0·253	164	2·075
Aug.	.	49	42	0·857	.	.	.	.	5	0·102	51	1·04	.	.	.	.	.	.	.	.	77	1·571	.	.	3	0·06	.	.	178	3·632
Sept.	.	240	46	0·191	.	.	.	.	.	.	401	1·67	12	0·05	.	.	.	.	.	.	183	0·762	5	0·02	.	.	36	0·15	683	2·845
Oct.	.	437	176	0·402	.	.	.	.	5	0·011	1,165	2·665	17	0·038	.	.	.	.	1	0·002	19	0·043	.	.	.	.	.	.	1,383	3·164
Nov.	.	319	186	0·383	.	.	.	.	10	0·031	739	2·316	4	0·012	.	.	.	.	.	.	8	0·025	3	0·009	.	.	51	0·159	1,001	3·137
Dec.	.	243	192	0·79	.	.	.	.	9	0·037	739	3·041	3	0·012	.	.	.	.	.	.	.	.	.	.	.	.	17	0·069	960	3·95
Totals,	246	2,563	3,620	1·288	22	0·007	.	.	237	0·08	5,242	1·866	52	0·018	.	.	3	0·001	1	0·0003	849	0·302	29	0·01	25	0·008	250	0·088	10,330	3·677

TABLE D.—*continued.*—CROMARTY DISTRICT.

Months.	Number of Shots.		Cod.		Ling.		Torsk (Tusk).		Salthe (Coalfish).		Haddock.		Whiting.		Turbot.		Halibut.		Sole (Lemon Sole).		Flounder, Plaice, Brill.		Eel.		Skate.		Other kinds of White Fish.		Total of Line-caught Fish.	
	Large Boats.	Small Boats.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.
Jan.	.	561	427	0·761	6	0·01	.	.	15	0·026	700	1·247	6	0·01	.	.	.	.	.	.	7	0·012	.	.	2	0·003	92	0·164	1,255	2·237
Feb.	.	458	218	0·475	2	0·004	.	.	4	0·008	441	0·962	2	0·004	.	.	.	.	.	.	112	0·244	.	.	2	0·004	66	0·144	847	1·849
March	.	548	303	0·552	.	.	.	.	12	0·021	446	0·813	3	0·005	.	.	.	.	.	.	261	0·476	.	.	2	0·003	67	0·122	1,094	1·978
April	.	581	291	0·5	.	.	.	.	11	0·018	396	0·681	4	0·006	.	.	.	.	.	.	80	0·135	.	.	23	0·039	92	0·156	897	1·543
May	.	508	297	0·584	.	.	.	.	9	0·017	500	0·984	5	0·009	.	.	.	.	.	.	29	0·057	.	.	38	0·074	72	0·141	950	1·87
June	.	530	396	0·747	.	.	.	.	6	0·011	338	0·637	6	0·011	.	.	.	.	.	.	39	0·073	.	.	12	0·022	54	0·101	851	1·605
July	.	189	76	0·402	.	.	.	.	.	.	229	1·212	.	.	.	.	.	.	.	.	23	0·121	.	.	5	0·026	48	0·253	381	2·015
Aug.	.	242	73	0·301	.	.	.	.	.	.	264½	1·092	4	0·016	.	.	.	.	.	.	66	0·272	.	.	2	0·008	35	0·144	444½	1·836
Sept.	.	521	156	0·299	.	.	.	.	.	.	695	1·333	3	0·005	.	.	.	.	.	.	60	0·115	.	.	.	.	77	0·147	991	1·902
Oct.	.	722	257	0·355	.	.	.	.	.	.	868	1·202	13	0·018	.	.	.	.	.	.	85	0·117	.	.	.	.	102	0·141	1,325	1·835
Nov.	.	680	241	0·354	.	.	.	.	6	0·008	769	1·131	6	0·008	.	.	.	.	.	.	38	0·055	.	.	.	.	79	0·116	1,139	1·675
Dec.	.	479	198	0·413	2	0·004	.	.	7	0·014	584	1·219	6	0·012	.	.	.	.	.	.	31	0·064	5	0·01	4	0·008	59	0·123	896	1·87
Totals,	.	6,019	2,933	0·487	10	0·001	.	.	70	0·011	6230½	1·035	58	0·009	.	.	.	.	.	.	831	0·138	5	0·0008	90	0·014	843	0·14	11,070½	1·839

TABLE D.—*continued.*—FINDHORN DISTRICT.

nths.	Number of Shots.		Cod.		Ling.		Torsk (Tusk).		Saithe (Coalfish).		Haddock.		Whiting.		Turbot.		Halibut.		Sole (Lemon Sole).		Flounder, Plaice, Brill.		Eel.		Skate.		Other kinds of White Fish.		Total of Line-caught Fish	
	Large Boats.	Small Boats.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.
Jan.	196	881	1,052	0·076	28	0·025	.	.	37	0·034	1,972	1·831	.	.	.	.	5	0·004	.	.	.	.	2	0·001	27	0·025	7	0·006	3,130	2·906
Feb.	284	548	1,529	1·837	24	0·028	.	.	20	0·024	1,151	1·383	.	.	.	.	5	0·006	.	.	78	0·094	4	0·004	23	0·027	7	0·008	2,841	3·414
March	236	863	1,511	1·374	41	0·037	.	.	34	0·03	1,272	1·157	5	0·004	.	.	3	0·002	.	.	939	0·854	13	0·011	29	0·026	3	0·002	3,850	3·503
April	100	714	340	0·417	169	0·207	.	.	8	0·009	601	·738	2	0·002	.	.	12	0·014	.	.	347	0·426	.	.	282	0·346	4	0·004	1,765	2·164
May	1	513	117	0·229	9	0·017	.	.	40	0·077	544	1·058	10	0·019	.	.	.	.	.	.	85	0·165	.	.	7	0·013	6	0·011	818	1·591
June	.	532	87	0·163	.	.	.	.	54	0·101	754	1·417	81	0·152	.	.	.	.	.	.	60	0·112	.	.	.	.	6	0·011	1,042	1·958
July	.	360	10	0·027	.	.	.	.	.	.	515	1·43	88	0·244	.	.	.	.	.	.	42	0·116	.	.	.	.	14	0·038	669	1·858
Aug.	11	429	10	0·022	.	.	.	.	.	.	693	1·575	183	0·415	.	.	.	.	.	.	78	0·177	.	.	.	.	4	0·009	968	2·2
Sept.	50	819	18	0·02	.	.	.	.	.	.	1,215	1·398	152	0·174	.	.	.	.	.	.	74	0·085	.	.	.	.	15	0·017	1,474	1·696
Oct.	83	1,187	148	0·116	.	.	.	.	.	.	1,991	1·567	50	0·039	.	.	.	.	.	.	216	0·17	.	.	.	.	19	0·014	2,424	1·108
Nov.	74	833	46	0·05	.	.	.	.	.	.	1,337	1·481	104	0·114	.	.	.	.	.	.	39	0·043	4	0·004	.	.	10	0·013	1,540	1·697
Dec.	88	600	143	0·207	.	.	.	.	1	0·001	992	1·441	56	0·081	.	.	.	.	.	.	6	0·081	.	.	.	.	5	0·007	1,203	1·748
Totals,	1,123	8,279	5,011	0·532	271	0·028	.	.	194	0·02	13,037	1·386	731	0·077	.	.	25	0·002	.	.	1,964	0·208	23	0·002	368	0·039	100	0·01	21,724	2·31

TABLE D.—*continued.*—BUCKIE DISTRICT.

Months.	Number of Shots.		Cod.		Ling.		Torsk (Tusk).		Saithe (Coalfish).		Haddock.		Whiting.		Turbot.		Halibut.		Sole (Lemon Sole).		Flounder, Plaice, Brill.		Eel.		Skate.		Other kinds of White Fish.		Total of Line-caught Fish.	
	Large Boats.	Small Boats.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average
Jan.	199	893	847	0·775	48	0·043	.	.	176	0·161	3,557	3·257	.	.	.	.	9	0·008	.	.	.	.	.	.	79	0·072	73	0·066	4,789	4·385
Feb.	50	290	1,512	4·447	81	0·238	.	.	78	0·229	2,530	7·441	.	.	.	.	15	0·044	.	.	.	.	5	0·014	95	0·279	62	0·182	4,378	12·876
March	212	366	1,934	3·346	192	0·332	.	.	164	0·283	738	1·276	9	0·015	.	.	2	0·003	.	.	19	0·032	23	0·039	323	0·588	103	0·178	3,507	6·219
April	35	327	430	1·187	35	0·096	.	.	65	0·179	374	1·033	4	0·011	.	.	12	0·033	.	.	3	0·008	.	.	130	0·359	10	0·027	1,063	2·936
May	.	617	155	0·251	.	.	.	.	66	0·106	527	0·853	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	748	1·212
June	.	1,153	482	0·418	.	.	.	.	140	0·121	861	0·746	30	0·026	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1,513	1·312
July	.	256	149	0·582	.	.	.	.	24	0·093	163	0·636	37	0·144	.	.	.	.	.	.	.	.	.	.	.	.	.	.	373	1·457
Aug.	.	185	7	0·037	.	.	.	.	8	0·043	140	0·756	12	0·064	.	.	.	.	.	.	.	.	3	0·016	.	.	.	.	170	0·918
Sept.	.	298	38	0·127	.	.	.	.	.	.	339	1·137	.	.	.	.	.	.	.	.	.	.	.	.	.	.	14	0·046	391	1·312
Oct.	17	843	168	0·195	.	.	.	.	.	.	1,833	2·131	.	.	.	.	.	.	.	.	4	0·004	.	.	.	.	19	0·022	2,024	2·353
Nov.	52	718	172	0·223	.	.	.	.	4	0·005	1,939	2·518	9	0·011	.	.	.	.	.	.	4	0·005	19	0·024	.	.	14	0·018	2,161	2·806
Dec.	142	495	223	0·35	.	.	.	.	6	0·009	1,470	2·307	.	.	.	.	.	.	.	.	.	.	10	0·015	.	.	29	0·045	1,738	2·728
Totals,	707	6,441	6,117	0·855	356	0·049	.	.	731	0·102	14,471	2·024	101	0·014	.	.	38	0·005	.	.	30	0·004	60	0·008	627	0·087	324	0·045	22,855	3·209

TABLE D.—*continued.*—BANFF DISTRICT.

Months.	Number of Shots.		Cod.		Ling.		Torsk (Tusk).		Saithe (Coalfish).		Haddock.		Whiting.		Turbot.		Halibut.		Sole (Lemon Sole).		Flounder, Plaice, Brill.		Eel.		Skate.		Other kinds of White Fish.		Total of Line-caught Fish.	
	Large Boats.	Small Boats.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.
Jan.	147	984	771	0·681	73	0·064	.	.	6	0·005	1,209	1·068	32	0·028	.	.	3	0·002	.	.	15	0·013	7	0·006	33	0·029	92	0·081	2,241	1·981
Feb.	135	1,099	451	0·365	36	0·029	.	.	5	0·004	2,061	1·662	38	0·03	.	.	5	0·004	.	.	3	0·002	.	.	14	0·011	81	0·066	2,694	2·175
March	78	814	249	0·279	8	0·008	.	.	5	0·005	977	1·095	10	0·011	.	.	2	0·002	3	0·003	.	.	.	.	.	.	31	0·034	1,285	1·440
April	23	843	135	0·155	15	0·017	.	.	169	0·195	1,303	1·504	31	0·035	.	.	2	0·002	.	.	12	0·013	.	.	15	0·017	58	0·066	1,740	2·009
May	.	683	86	0·125	12	0·017	15	·021	211	0·308	1,221	1·787	153	0·224	.	.	3	0·004	.	.	.	.	3	0·004	6	0·008	43	0·063	1,753	2·566
June	.	524	62	0·118	.	.	.	.	370	0·706	542	1·034	126	0·24	.	.	.	.	.	.	3	0·005	.	.	.	.	18	0·034	1,121	2·139
July	.	227	6	0·026	.	.	.	.	140	0·616	190	0·837	65	0·286	.	.	.	.	.	.	4	0·013	.	.	.	.	23	0·101	428	1·885
Aug.	.	250	9	0·036	.	.	.	.	65	0·26	211	0·884	90	0·36	.	.	.	.	.	.	4	0·016	.	.	.	.	18	0·072	397	1·588
Sept.	.	924	47	0·05	.	.	.	.	.	.	1,596	1·727	201	0·217	.	.	.	.	.	.	17	0·018	.	.	.	.	45	0·048	1,906	2·062
Oct.	6	1,482	288	0·193	4	0·002	.	.	.	.	2,272	1·526	33	0·022	.	.	.	.	.	.	6	0·004	.	.	.	.	-	-	2,603	1·749
Nov.	22	1,113	316	0·278	7	0·006	.	.	8	0·007	1,046	0·921	10	0·008	.	.	.	.	.	.	51	0·044	8	0·007	12	0·01	20	0·017	1,478	1·303
Dec.	21	685	226	0·32	13	0·018	.	.	.	.	521	0·737	5	0·007	.	.	3	0·004	.	.	3	0·004	6	0·008	19	0·022	29	0·041	825	1·168
Totals,	432	9,628	2,646	0·262	168	0·016	15	0·001	979	0·097	13,149	1·306	794	0·078	.	.	18	0·001	3	0·0002	118	0·011	24	0·002	99	0·009	458	0·045	18,471	1·834

TABLE E.—TOTAL QUANTITIES OF FISH CAUGHT BY LINE IN 1900 WITHIN THE MORAY FIRTH (INSIDE A LINE BETWEEN DUNCANSBY HEAD AND RATTRAY POINT), AND THE NUMBER OF SHOTS OF THE BOATS BY WHICH THE FISH WERE CAUGHT.

Districts.	Number of Shots.		Cod.		Ling.		Torsk (Tusk).		Saithe (Ccalfish).		Haddock.		Whiting.		Turbot.		Halfbut.		Sole (Lemon Sole).		Flounder, Plaice, Brill.		Eel.		Skate.		Other kinds of White Fish.		Total of Line-caught Fish.	
	Large Boats.	Small Boats.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.
Wick, . .	1,524	,751	11,244	2·1	1,565	0·296	3	0·0005	6,57	1·205	,26	0 ·42	.	.	4	0·0007	164	0·031	.	.	446	0·084	180	0·034	1,300	0·246	428	0·081	23,927	4·535
Lybster, .	1 ,56	766	2,001	0·869	.	.	.	.	558	0·242	522	0·226	.	.	.	.	5	0·002	.	.	4	0·001	12	0·005	.	.	366	0·158	3,468	1·506
Helmsdale, .	246	2,56	,620	1·288	22	0·007	.	.	27	0·08	5,242	1·866	52	0·018	.	.		0·001	1	0·0003	849	0·302	29	0·01	25	0·008	250	0·088	10,330	3·606
Cromarty, .	.	6,019	2,9	0·487	10	0·001	.	.	70	0·011	6,230½	1·035	58	0·009	.	.	.	.	.	.	831	0·138	5	0·0008	90	0·014	843	0·14	11,070½	1·839
Findhorn, .	1,123	8,279	5,011	0·532	271	0·028	.	.	194	0·02	13,037	1· 86	71	0·077	.	.	25	0·002	.	.	1,964	0·208	23	0·002	368	0·039	100	0·01	21,724	2·31
Buckie, .	707	6,441	6,117	0·855	56	0·049	.	.	71	0·102	14,471	2·024	101	0·014	.	.	38	0·005	.	.	30	0·004	60	0·008	627	0·087	324	0·045	22,855	3·209
Banff, . .	4 2	9,628	2,646	0·262	168	0·016	15	0·001	979	0·097	1,149	1·96	794	0·078	.	.	18	0·001	3	0·0002	118	0·011	24	0·002	99	0·009	458	0·045	18,471	1·834
Totals, .	5,595	7,447	,57 2	0·779	2,9 2	0·055	18	0·0004	9,126	0·212	54,887½	1·275	1,736	0·04	4	.	253	0·005	4	0·00009	4,242	0·098	333	0·007	2,509	0·058	2,769	0·064	111,845½	2·600

II. INVESTIGATIONS MADE ON BOARD STEAM TRAWLERS.

I.

By T. Wemyss Fulton, M.D., F.R.S.E., Scientific Superintendent.

The Board having granted authority for the occasional employment of steam trawlers within the Moray Firth or other parts of the territorial waters of Scotland, on condition that no expense was thereby incurred, arrangements were made at Aberdeen for the purpose, and the chief results of a number of trips of this kind are given in the following pages. Since better catches, especially of flat-fishes, are secured inshore within the closed waters than on the offshore grounds, no difficulty was experienced in obtaining the use of trawlers for the work. The other conditions imposed were that facilities were to be given for the examination, enumeration, and measurement of the fish caught, for the use of tow-nets, for experimental hauls with cod-ends of different mesh, and with small-meshed netting around the cod-end, and for certain hauls to be taken in specified places. Otherwise, the vessels were allowed to carry on their trawling operations within the area assigned, wherever the skipper thought best, and the places selected were naturally those where fish were believed to be most abundant.

The steam trawlers employed were the *St. Andrew* (Captain Caie) and the *Star of Hope* (Captain Murray); and I have to thank the gentlemen named, as well as the owners, Messrs. Thomas Walker & Sons, for the facilities they willingly gave. Each vessel used an otter-trawl of the usual form. That of the *St. Andrew* had a head-line of 120 feet, while the head-line of the trawl of the *Star of Hope* was 108 feet in length.

The localities where the trawling operations were carried on were the Moray Firth and Aberdeen Bay, and, by the courtesy of Captain Caie, two trips were also made on the *St. Andrew* to the deep-sea grounds. The principal objects in view were (1) to obtain definite records, which would be useful for future comparison, of the abundance of the various kinds of fish on the grounds visited; (2) to ascertain the proportion of small and unmarketable fishes to the marketable in each haul of the net; (3) to discover the proportion of immature fish caught by the trawl, and whether it were practicable to lessen the quantity of immature fish so taken by enlarging the mesh of the net; (4) to investigate the rate of growth of fishes. (*See* p. 154.)

Before dealing with these questions, it may be desirable to describe the routine work on board a steam trawler while on the fishing grounds. The selection of the place of fishing is, in ordinary circumstances, left entirely to the skipper of the vessel, and, since he and the mate are paid by the results of the trip, such grounds are naturally selected as may give the best returns. Each vessel is provided with two fully-equipped otter-trawls, so that if one be damaged the other may be used without causing delay in the work. The duration of the hauls varies according to the ground, the weather, and the abundance of fish. On the offshore grounds the drags are usually for five hours; but while working in Aberdeen Bay and the Moray Firth they were, as a rule, shorter—generally three or four hours. When the net is brought alongside, the crew lie over the gunwale and gather in the loose net, bringing the ground-rope on board as soon as they can. When the bag of fish is brought to the surface, a rope is passed round the neck of the

cod-end, and the whole is then hoisted on board by the aid of the steam-winch and suspended over the "pound"—a part of the fore-deck having strong upright boards fixed into slots, so as to form a compartment for receiving the fish. One of the men then creeps below the bag and unfixes the greased rope by which the opening in the cod-end is tied up—an operation not unattended with risk when the vessel is rolling heavily. The contents of the net then fall into the pound.

The first duty after the "bag" of fish has been emptied into the pound is to get over the net again for another drag. It is usually the same net that is used—unless it has been badly torn, when the other trawl is shot instead. The time taken to haul the net, to empty it of fish, and to shoot it once more, varies from several circumstances—especially the condition of the weather, the quantity of fish, the depth of water, and the amount of damage to the net, if any; it is generally from about half to three-quarters of an hour. Immediately after the net has been again shot, all the hands, except the skipper at the wheel and the engineers, begin to deal with the catch. They sit around the pound and select the various kinds of fish from the mass, tossing them into baskets according to their kind and quality, and pitching overboard the "rubbish" as they come across it, and which consists of the unmarketable fishes, sea-weeds, shells, stones, sticks, and various invertebrates. It was, however, necessary for the proper registration of the hauls while our investigations were going on that all the fishes and the residue of the catch should be kept on deck for examination and this rule was enforced on all occasions.

The flat-fishes are never gutted, nor were cod, or, indeed, any descriptions except haddocks, codlings, and skates. Cod and whitings are sometimes gutted in summer. Plaice (usually called "flats") are assorted into three sizes—large, medium, and small; lemon dabs are assorted into large and small, as are also witches and megrims. Common dabs, which may be taken to market in considerable quantities and are locally known as "satties," are placed separately, but they are sometimes mixed with small plaice if the quantity of the latter is small. Haddocks are separated into three classes—large, medium, and small (called "firsts," "seconds," and "thirds")—and they are always gutted, unless those of the last haul or two (if the vessel is near enough port), which may be left ungutted; these are known as "rounds" or "live" haddocks, and command a better price. Whitings, which are occasionally gutted, are divided into large and small. The only fish that was regularly "bled" was the turbot. When the baskets are full the fish are well soused with the hose, and are then lowered into the fish-hold and packed with ice in the compartments and shelves. When the fish have been packed away the remaining "rubbish" is shovelled overboard, and the deck and the pound thoroughly washed with the hose. The men then go to their meals and "turn in" to sleep until the net is again hauled.

While on the fishing grounds the work is extremely hard and constant, especially if the hauls are frequent and haddocks abundant. The gutting of the haddocks when the quantity is large is tedious and takes a long time, and all the work is, of course, done without shelter on the open deck; and in winter and stormy weather the men are consequently much exposed.

I have to thank Mr. H. Dannevig and Mr. P. Jamieson for much assistance in tabulating the catches. The records of the hauls in deep water in October were all made by Mr. H. Dannevig, with the exception of those referring to the small fishes caught in the fine-meshed net, which were brought to the Laboratory preserved in a solution of formaline.

The Fish caught on the Different Grounds.

Inasmuch as these investigations were carried on only in autumn and are now being continued, particular comparison of the hauls on the different grounds will be of more value when fuller information is acquired at various seasons of the year and a chart showing their position has been prepared. In the Tables appended to this paper details for each haul are given, indicating the number of the various kinds of fishes caught and the place where the hauls were made.

With regard to the question as to whether the abundance of the food-fishes has increased or diminished in recent years on the grounds visited, there are, unfortunately, no records existing with which the present ones can be compared. The hauls of the *Garland* in the Moray Firth and Aberdeen Bay were made with a small beam-trawl (25 feet), and are of little or no use for comparison, as many fish being caught in one haul of the large otter-trawl of the *St. Andrew* as in many hauls by the *Garland*. It may, however, be of much importance at some future time to have records for comparison such as those now published.

It will be seen from the Tables that in the inshore waters of the Moray Firth and Aberdeen Bay fish were, as a rule, abundant. It was no uncommon thing, for example, to catch from 1200 to 1500 or 1600, and even sometimes over 2000, plaice in a single drag of four hours in the Dornoch Firth in November, the great majority of which were of marketable size. Further north, on harder ground and in deeper water, more than 300 lemon soles were procured in a single drag. The quantity of haddocks taken varied very considerably on the same grounds at different times. The largest haul was made by the *St. Andrew* in Aberdeen Bay in October, when 3891 were taken, of which all but 5 were marketable. The greatest number of whitings taken in one drag was in Aberdeen Bay in October, viz., 1042, but of these only 182 were marketable. One of the features of the condition of the inshore waters at the time the hauls were made was the presence of great shoals of immature whitings, the majority of which were under six inches in length. Small cod were also fairly numerous, but young haddocks were much less abundant.

On the deep-sea grounds scarcely any young whitings or haddocks were obtained, the place of the former being taken by a small species of the cod tribe—the Norway Pout—which was occasionally caught in thousands in a single haul of the fine-meshed net. This fish was not previously known to exist on these grounds. Another feature was the paucity of plaice, and they were all of large size. On the other hand, witches, megrims, and long rough dabs were most numerous on the offshore grounds, but young specimens of the two former species were scarce and none of them were very small. Long rough dabs, on the contrary, were procured of all sizes in abundance.

The Marketable and Unmarketable Fishes.

In recording the fishes caught, care was taken to distinguish between those which were put into the fish-hold for market and those which were rejected aud thrown overboard, and they are separately stated in the Tables. Among the latter are always included such fishes as dog-fishes, anglers, and long rough dabs, which are not used as food, and also those edible fishes which are too small to be placed on the market. In both cases, however, variation in the practice occurs. It used to be common for anglers and others to be taken ashore, when they were the perquisite of the crew. Gurnards are sometimes

taken to market at Aberdeen. On the occasions in question they were always thrown overboard, although sometimes as many as 400, many of them of large size, were caught in a single drag. Large common dabs are usually taken to market, and sometimes many of a medium size—the quantity of the latter depending in large measure upon the quantity of other flat-fish obtained; when plaice are abundant comparatively little attention is paid to dabs. The numbers of small plaice taken to market was surprisingly large; a few years ago they would have been thrown overboard with the "rubbish."

The proportion of the edible fishes caught in the net which are rejected because of their small size varies with different species and on different grounds, but it is, as a rule, small. Of 2306 cod and codlings brought on board, 2052 were marketable and 254 were thrown overboard, the proportion of the latter being therefore about 11 per cent. The highest percentage was found in the hauls made inshore, especially in the Moray Firth. On the deep-sea grounds the number of codlings rejected as undersized was only 16 in a total catch of 1075; the proportion was therefore only about 1½ per cent. Of 220 ling taken, only 1 was of an unmarketable size, and it was caught in Aberdeen Bay. Four saithe of a total of 58 were unmarketable, 1 tusk out of 46, and 2 hake of a total of 375. Among haddocks, the proportion of those rejected because of their unmarketable size was small, viz., 780 out of a total of 47,758, or slightly over 1½ per cent. Here also the higher proportions were in inshore waters; in Aberdeen Bay it was about 2⅓ per cent.; in the Moray Firth and on the deep-water grounds it was a little over 1 per cent.

The number of whitings discarded because of their small size is relatively greater. Of a total of 8483 caught, no less than 2530, or nearly 30 per cent., were not brought to market. The abundance of undersized whitings in the hauls in the inshore waters was specially noteworthy, and contrasted with the condition on the deep-water grounds. In Aberdeen Bay, of a total number of 3264 whitings taken, no less than 2324 were rejected, and only 940 taken to market. In the Moray Firth the proportion was 21 per cent., while on the deep-water grounds it was under 1 per cent., only 34 being found unmarketable among 4400 caught. The difference was caused by the presence of great shoals of small whitings in the inshore waters in autumn (see p. 166).

With regard to flat-fishes, long rough dabs are not taken to market, and only a certain number of common dabs, according to circumstances. The quantity of plaice caught in these hauls was considerable, viz., 26,047, and of these, 3712, or about 14 per cent., were thrown overboard as undersized. The proportion of these small plaice varied very much in different hauls, according as to whether the net was carried into shallow water or not, and it was highest in some of those made in the Moray Firth, where the proportion was about 17 per cent. In Aberdeen Bay it was much lower, only slightly over 1 per cent.; while on the deep-water grounds, where plaice are very scarce, none of an unmarketable size were found. Among lemon soles, the proportion of the undersized was about 19 per cent., 305 being rejected from a total of 1557. In the Moray Firth the percentage was rather higher, viz., nearly 20; in Aberdeen Bay, where, however, few were taken, it was higher still; on the deep-water grounds it was about 15 per cent. Of a total of 2259 witches caught, 143, or about 6 per cent., were undersized; and this was also about the proportion of the unmarketable among the 733 megrims or sail-flukes taken. None of the brill or turbot were undersized, but the numbers were small—72 and 6 respectively; and of 53 halibut only 1 was unmarketable. The number of common dabs taken to market

was 8484 of a total of 33,259 caught. Among skates and rays the proportion that was unmarketable varied widely. Of 980 starry rays, only 152 were boxed; all the white skates—42 in number—were marketable; of 117 grey skates, 44 were unmarketable; while 81 of 123 thornbacks were unmarketable. I append a Table showing the numbers of those taken to market and those rejected of the more important edible fishes caught—the former in Column I., and the latter in Column II.

Cod.		Ling.		Saithe.		Tusk.		Hake.		Haddock.		Whiting.	
I.	II.	I.	II.	I.	II.	I.	II.	I.	II.	I.	II.	I.	II.
2,052	254	220	1	54	4	45	1	373	2	46,978	780	5,953	2,530

Halibut.		Turbot.		Brill.		Plaice.		Lemon.		Witch.		Sail-fluke.	
52	1	6	..	72	..	22,335	3,712	1,252	305	2,116	143	689	44

Flounder.		Com. Dab.		Grey Skate.		White Skate.		Starry Ray.		Thornback.		Cat-fish.	
81	13	8,484	24,775	73	44	42	..	152	828	42	81	12	1

The Influence of the Size of Mesh of the Net.

In order to ascertain the proportion of undersized fish which were caught in the trawl and the proportion which escaped through the meshes of the net, the cod-end was on several occasions enveloped in a bag of netting with half-inch meshes, so that the small fishes that passed might be retained. There is, perhaps, no error so prevalent among fishermen as that which involves the supposition that the mesh of the trawl-net has little relation to the size of the fish caught by it. It is believed that the traction on the net as it is dragged along the bottom closes the meshes, so that very small fish, if they once enter, are captured; and this opinion was expressed by all the fishermen on board the trawlers when the experiments were about to be made. They thought that very few fish would be found in the small-meshed net. In point of fact, the number of fish thus caught was always much greater than the number retained in the otter-trawl, and was sometimes surprisingly large. In one haul of 3¼ hours, for example, in Aberdeen Bay in December, while the catch of the otter-trawl was moderate—comprising 872 fishes—the quantity of fishes that had passed through the meshes and were caught in the fine outer net was so great that the latter burst from the weight of fish while being got on board, and it was estimated that only about one-third was secured; yet they numbered 9158, the great majority being whitings.

With the exception stated, the hauls with the small-meshed net were much shorter, varying from 45 minutes to 90 minutes—usually the latter; and in ten hauls, comprising altogether a period of 15 hours, 38,243 fishes were taken, of which 32,337 had escaped through the meshes of the ordinary otter-trawl and were caught in the small-meshed net, the other 5906, or about 19 per cent., being caught in the trawl itself. It is therefore evident that in the ordinary trawling operations enormous numbers of immature fishes must enter, and escape from, the otter-trawl. Fifteen hours represent three, or rather more than three, ordinary drags. With very few exceptions these small fishes were lively and vigorous when brought on board; the small whitings and even the young herrings, which most readily suffer injury and succumb, were

in this condition, jumping from the baskets in which they were placed; the young flat-fishes were always living. In the 3¼ hours' drag above referred to, when the net burst, the water for some distance from the side of the vessel was whitened with the multitude of young fishes which were swimming about; but, in this case, some of them were obviously injured from the length of the drag. Instead, therefore, of the meshes of the trawl-net being brought together by the traction when fishing, they appear to be kept wide open; and the fishes which enter the net, if small enough to escape, pass through them uninjured.

The particulars of the experiments with the ordinary cod-end are indicated in the following Table, the size of the fishes being given in inches:—

Fish.	I.—Caught in Trawl-Net. 1½" Cod-end.			II.—Passed through meshes of Trawl-Net and caught in Small-meshed Net outside.		
	Number.	Largest.	Smallest	Number.	Largest.	Smallest
Cod,	49	27	5⅜	345	8 5/16	2⅜
Ling,	1	30½	...	...	...	...
Hake,	28	40¾	14½	...	...	...
Haddock,	1,790	26	6 1/16	523	9¼	3¼
Whiting,	681	20¾	5¼	15,273	11¼	2⅜
Halibut,	2	23½	14	...	...	...
Brill,	3	17⅝	12	...	...	...
Plaice,	1,277	26¾	4 1/16	5	4¾	2⅞
Lemon Dab,	32	16	6⅜	34	8¼	4¼
Common Dab,	1,558	15⅝	4½	3,599	9	1½
Flounder,	14	11¾	9½	...	...	...
Long Rough Dab,	164	8¾	4¼	1,765	9⅛	1⅝
Witch,	7	15⅛	9⅛	...	...	...
Sail-fluke,	32	20¼	5¾	1	7½	...
Gurnard,	206	16½	5⅛	123	9¼	2⅝
Dragonet,	4	9⅞	6½	22	8 1/16	3⅛
Argentine,	1	7⅞	...	62	8 1/16	3⅜
Norway Haddock,	2	7¼	6	5	5½	3 7/16
Pogge,	1	5¾	...	34	5⅛	1⅞
Herring,	13	6¼	5¼	3,230	8½	2 1/16
Starry Ray,	29	12	10⅛	...	...	...
Grey Skate,	2	20½	16¾	...	...	...
Thornback,	3	22	12	...	...	...
Picked Dog,	3	31½	25	...	...	...
Angler,	4	27¼	9⅛	...	...	...
Norway Pout,	...	...	...	7,027	7 9/16	1¼
Solenette,	...	...	...	4	4½	2½
Sprat,	...	...	...	285	5⅛	2⅝
	5,906	...	...	32,337	...	...

The species of fishes which escaped in this way varied according to the grounds worked over. In the inshore waters, and especially in Aberdeen Bay, the great majority were whitings. They numbered 15,273 of the total above mentioned, and they ranged in size from an extreme of 11¼ inches to 2⅜ inches, most of them being under 6 inches in length. The number of whitings caught in the otter-trawl in the ten hauls referred to was 681. The next most abundant was the common dab, of which 3599, ranging from 9 inches to 1½ inches, passed through the meshes of the trawl net, while 1558 were retained in it. The number of young herrings, ranging from 8½ inches to 2 1/16 inches, which escaped from the trawl was also considerable, viz., 3230, while only 13 were found in the trawl itself; and all the sprats caught—285—were taken from the fine-meshed net. Of 394 cod which were got, 345, measuring from 8 3/16 inches to 2⅜ inches, passed through the meshes of the otter-trawl. The proportion of young haddocks taken in this way was much less, no doubt because they do not frequent the bottom in large numbers; the number caught in the trawl was 1790, and the number which escaped from it was 523.

On the offshore grounds the only fishes which escaped in numbers through the meshes of the otter-trawl were the Norway pout and the long rough dab. The number of the former was 7027, and not a single specimen of it was got in the trawl. As with the common dab, but to a greater degree, most of the long rough dabs which enter the trawl-net escape from it. Of a total of 1929 which were caught, 1765, or over 91 per cent., made their way out again through the meshes. It is very different with plaice, only 5 of a total of 1282, or about 0·4 per cent., escaping in this way, the largest of these being 4¾ inches in length. Of 329 grey gurnards taken in these experimental hauls, 206 were retained in the trawl, while 123, or 37 per cent., escaped, the largest being 9¼ inches.

The suggestion has been sometimes made that the enlargement of the mesh of the trawl-net would be an advantage by allowing immature fish to escape in larger numbers than they can in the ordinary net with 1½-inch meshes. Experiments were accordingly made with cod-ends of a larger mesh—namely 2 inches and 2½ inches. I append a Table of the results of three hauls with a cod-end having 2-inch meshes:—

Fish.	I.—Caught in Trawl-Net. 2" Cod-end.			II.—Passed through meshes of Trawl-Net and caught in Small-meshed Net outside.		
	Number.	Largest.	Smallest	Number.	Largest.	Smallest
Cod,	19	44½	11⅝	315	12¾	3⅛
Hake,	1	33⅞	...	...	...	...
Haddock,	778	24¼	9⅝	1,043	12¼	5
Whiting,	46	12½	7½	18,010	12¾	2¾
Brill,	4	18⅛	15⅛	...	...	...
Plaice,	783	26½	6¼	96	8 3/16	3
Lemon Dab,	11	15¾	9 1/16	13	9¾	3⅞
Common Dab,	603	17	6⅜	4,987	9⅜	2⅜
Long Rough Dab,	3	9¾	8 11/16	4	8¼	5⅞
Gurnard,	9	17¾	8⅜	50	11 1/16	3
Starry Ray,	4	11⅜	6½	...	...	...
Thornback,	5	13¾	9⅛	...	...	...
Angler,	8	23	13½	1	5	...
Dragonet,	...	...	...	4	8¼	5 13/16
Solenette,	...	..	...	14	4¼	2⅛
Pogge,	...	...	...	37	5 3/16	2
Herring,	...	...	...	4,772	8⅛	2⅞
	2,274	...	...	29,346	...	...

The total number of fish taken was 31,620, of which 29,346 passed through the meshes of the cod-end, while 2274, or a little over 7 per cent., were caught in it. Here again the great majority were whitings, and it is noteworthy that only 46 of a total of 18,056 were retained in the trawl. The majority of the haddocks also escaped—viz., 57 per cent.—and some of them were over 12 inches in length. Of 334 cod which entered the net in these drags, 19 were caught in the trawl, and 315, or 94 per cent., made their way out of it, some of them being 12¾ inches long. The number of common dabs taken was 5590, of which 4987, or 89 per cent., passed through the meshes of the cod-end. The proportion of plaice which escaped in this way was not nearly so great, although much higher than with the ordinary cod-end of 1½-inch mesh. The total number caught was 879, and of these 783 were retained in the trawl, while 96, or almost 11 per cent., escaped from it; some of them were nearly 8¼ inches in length. All the herrings caught—4772 in number—passed through the meshes of the trawl; the largest herring was 8⅛ inches long.

Other hauls were made with a cod-end having 2½-inch meshes; and of 9355 fishes caught, only 282 were retained in the trawl, the other 9073, or 97 per cent. of the total, passing through the meshes. Only 1 of the 8551 whitings which entered the net was retained by it, and it

was of a size which might easily have escaped. The majority of the haddocks also escaped, and some of them were over 18 inches in length and weighed nearly 2 lbs. The number of plaice taken was 242, of which 54, or 22 per cent., escaped; some of them were nearly 10 inches in length and weighed about 6 ozs. The eight largest measured as follows, in inches:—$9\frac{7}{8}$, $9\frac{7}{8}$, $9\frac{3}{4}$, $9\frac{1}{2}$, $9\frac{1}{2}$, $9\frac{1}{2}$, $9\frac{1}{4}$, $9\frac{1}{16}$.

Fish.	I.—Caught in Trawl-Net. $2\frac{1}{2}$" Cod-end.			II.—Passed through meshes of Trawl-Net and caught in Small-meshed Net outside.		
	Number.	Largest.	Smallest	Number.	Largest.	Smallest
Cod,	36	$40\frac{1}{8}$	21	18	$10\frac{1}{8}$	$3\frac{1}{4}$
Haddock,	23	$24\frac{3}{4}$	15	39	$18\frac{1}{4}$	$14\frac{1}{16}$
Whiting,	1	$10\frac{1}{8}$	...	8,550	$11\frac{1}{2}$	$2\frac{1}{4}$
Plaice,	188	26	$7\frac{1}{4}$	54	$9\frac{7}{8}$	$6\frac{3}{4}$
Lemon Dab,	5	$14\frac{1}{4}$	$11\frac{3}{8}$	4	$6\frac{9}{16}$	$3\frac{3}{8}$
Common Dab,	2	$11\frac{3}{4}$	$10\frac{5}{8}$	326	$9\frac{1}{2}$	$1\frac{15}{16}$
Long Rough Dab,	...	...	...	1	$6\frac{3}{4}$	...
Gurnard,	2	$16\frac{1}{16}$	$11\frac{3}{8}$	7	$8\frac{1}{4}$	$3\frac{1}{8}$
Starry Ray,	19	$12\frac{3}{8}$	$6\frac{7}{8}$	...	...	...
Thornback,	5	$16\frac{3}{4}$	$9\frac{1}{8}$	...	...	...
Angler,	1	14	...	...	...	...
Solenette,	...	...	...	3	$3\frac{3}{4}$	$3\frac{1}{4}$
Pogge,	...	...	...	4	$4\frac{1}{8}$	$2\frac{3}{16}$
Herring,	...	...	...	16	$9\frac{1}{2}$	$2\frac{15}{16}$
Norway Pout,	...	...	...	51	$4\frac{1}{2}$	$3\frac{3}{8}$
	282	...	...	9,073	...	...

These experiments show that it would be impracticable, in the ordinary mixed fishing as practised by trawlers, to enlarge the mesh of the net to any extent. A comparatively slight enlargement would allow very considerable numbers of eminently marketable round-fishes—such as haddock, cod, and whiting—to escape, and fishing of this kind with a mesh of $2\frac{1}{2}$ inches would be unprofitable. It would, however, be feasible to have an enlarged mesh—and one even larger than $2\frac{1}{2}$ inches—for the capture of plaice; and, supposing it were otherwise desirable, there is little doubt that trawlers would be quite willing to make use of a net of this description if they were allowed to fish inshore, because the quantity of plaice above 10 or 12 inches in length they would catch would make the fishing profitable.

Appended are the Tables giving the details of each haul.

TRAWLING INVESTIGATIONS.

ace.	Date.	Temperature. Air.	Surface.	Bottom.	Depth in Fms.	Time Trawl Down. Shot.	Hauled.	Fish Caught. Name.	No. taken to Market.	No. thrown Overboard.	Total No.	Remarks.
about es S.E. E. of burgh ead, land.	1900. Sept. 3.	..	..	..	65	1.45 a.m.	6.45 a.m.	Cod, ...	10	..	10	Steam trawler "St. Andrew."
								Codling, ...	39	..	39	
								Ling, ...	1	..	1	
								Saithe, ...	3	..	3	
								Tusk, ...	1	..	1	
								Haddock, ...	1592	48	1640	
								Whiting, ...	92	..	92	
								Witches, ...	113	6	119	
								Sail-fluke, ...	11	1	12	
								Lemon Dab, ..	1	..	1	
								Com. Dab, ...	..	9	9	
								Long Rough Dab,	..	68	68	
								Starry-ray, ..	..	4	4	Heavy sea, rain; wind W.N.W.
								Grey Skate, ..	..	1	1	
								Angler, ...	..	2	2	
									1863	139	2002	
Same ality.	Sept. 3.	..	..	..	68	7.40 p.m.	12.40 p.m.	Cod, ...	2	..	2	
								Codling, ...	32	..	32	
								Hake, ...	2	..	2	
								Haddock, ...	2386	21	2407	
								Whiting, ...	51	1	52	
								Halibut, ...	1	..	1	
								Witches, ...	89	3	92	
								Sail-fluke, ...	8	..	8	
								Lemon Dab, ..	2	..	2	
								Com. Dab, ...	..	4	4	
								Long Rough Dab,	..	35	35	
								Cat-fish, ...	1	..	1	
								Starry-ray, ..	..	1	1	
								Angler, ...	..	4	4	
									2574	69	2643	
Same ality.	Sept. 3.	..	..	..	68	1.20 p.m.	6.30 p.m.	Cod, ...	4	..	4	
								Codling, ...	67	..	67	
								Ling, ...	2	..	2	
								Tusk, ...	2	..	2	
								Hake, ...	2	..	2	
								Haddock, ...	2174*	28	2202	*16 baskets firsts, 4 seconds, and 5 thirds.
								Whiting, ...	284	7	291	
								Grey Gurnard, ..	..	12	12	
								Halibut, ...	1	..	1	
								Witches, ...	..	7	7	
								Sail-fluke, ...	3	..	3	
								Lemon Dab, ..	..	1	1	
								Com. Dab, ..	..	8	8	
								Long Rough Dab,	..	49	49	
								Starry-ray, ..	..	7	7	
								Grey Skate, ..	2	..	2	
								Picked-dog, ..	..	1	1	
								Angler, ...	..	2	2	
									2541	122	2663	
Same ality.	Sept. 4.	..	..	..	67	12.50 a.m.	5.50 a.m.	Cod, ...	4	..	4	
								Codling, ...	14	..	14	
								Hake, ...	1	..	1	
								Haddock, ...	2149	17	2166	
								Whiting, ...	41	1	42	
								Halibut, ...	1	..	1	
								Witches, ...	120	5	125	
								Sail-fluke, ...	7	1	8	
								Com. Dab, ...	..	3	3	
								Long Rough Dab,	..	58	58	
								Starry-ray, ..	..	14	14	
								Raia fullonica, ..	3	..	3	
								Angler, ...	..	9	9	
									2340	108	2448	

TRAWLING INVESTIGATIONS.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarl
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Over-board.	Total No.	
5. Same Locality.	1900. Sept. 4.	..	12·9	..	67	6.45 a.m.	11.45 a.m.	Cod, ...	1	..	1	State of w and sea as
								Codling, ...	26	..	26	
								Saithe, ...	1	..	1	
								Haddock, ...	2115	17	2132	
								Whiting, ...	174	..	174	
								Halibut, ...	2	..	2	
								Witches, ...	168	4	172	
								Sail-fluke, ...	7	..	7	
								Com. Dab, ...	..	17	17	
								Long Rough Dab,	..	79	79	
								Starry-ray, ..	..	16	16	
								Cat-fish, ...	1	..	1	
								Angler, ...	..	2	2	
									2495	135	2630	
6. Same Locality.	ept. 4.	..	..	..	63	12.37 p.m.	2.37 p.m.	Cod, ...	3	..	3	
								Codling, ...	7	..	7	
								Haddock, ...	369	8	377	
								Whiting, ...	38	..	38	
								Witches, ...	28	1	29	
								Sail-fluke, ...	3	1	4	
								Lemon Dab, ..	.	1	1	
								Com. Dab, ...	..	12	12	
								Long Rough Dab,	..	53	53	
								Grey Skate, ..	1	2	3	
									449	78	527	
1. Aberdeen Bay, between the Black Dog and Newburgh, 1 to 1½ miles off.	Oct. 8.	..	53·3	53	10 to 16	9.15 a.m.	1.45 p.m.	Cod, ...	6	..	6	Steam trawle of Hope."
								Codling, ...	..	2	2	
								Haddock, ...	1720	7	1727	
								Whiting, ...	126	459	585	
								Plaice, ...	56	..	56	
								Com. Dab, ...	801	195	996	
								Lemon Dab, ..	1	..	1	
									2710	663	3373	
2. Same Locality.	Oct. 8.	..	..	..	12 to 14	3.15 p.m.	5.15 p.m.	Cod, ...	1	..	1	
								Ling, ...	..	1	1	
								Haddock, ...	1115	23	1138	
								Whiting, ...	182	860	1042	
								Brill, ...	1	..	1	
								Plaice, ...	79	..	79	
								Lemon Dab, ..	8	..	8	
								Com. Dab, ...	453	169	622	
								Grey Gurnard, ..	..	69	69	
								Angler, ...	..	8	8	
									1839	1130	2969	
3. Same Locality.	Oct. 8.	..	..	..	12 to 16	6.5 p.m.	8.15 p.m.	Cod, ...	1	..	1	
								Codling, ...	16	7	23	
								Haddock, ...	805	17	822	
								Whiting, ...	90	169	259	
								Plaice, ...	40	2	42	
								Com. Dab, ...	430	510	940	
								Grey Gurnard, ..	..	10	10	
								Sandy-ray, ..	..	1	1	
								Angler, ...	..	1	1	
									1382	717	2099	

TRAWLING INVESTIGATIONS.

ace.	Date.	Temperature. Air.	Surface.	Bottom.	Depth in Fms.	Time Trawl Down. Shot.	Hauled.	Fish Caught. Name.	No. taken to Market.	No. thrown Overboard.	Total No.	Remarks.
erdeen ay, een the k Dog nd burgh, ½ miles ff.	1900. Oct. 8 and 9.	..	..	..	9	10.30 p.m.	2.45 a.m.	Codling, ... Haddock, ... Whiting, ... Brill, ... Plaice, ... Black Sole, .. Com. Dab, ... Grey Gurnard, .. Angler, ...	10 1184 70 2 190 1 440	9 7 178 .. 7 .. 419 35 14	19 1191 248 2 197 1 859 35 14	
									1897	669	2566	
ame ality.	Oct. 9.	..	52·8	53	16	4.0 a.m.	7.0 a.m.	Cod, ... Haddock, ... Whiting, ... Lemon Dab, .. Plaice, ... Com. Dab, ... Sandy-ray, .. Grey Skate, ..	1 1679 83 1 13 480 1 1	.. 8 120 .. .. 121	1 1687 203 1 13 601 1 1	
									2259	249	2508	
loray rth, ween le and mo'th	Oct. 9.	..	..	..	19	9.15 p.m.	11.15 p.m.	Haddock, ... Whiting, ... Plaice, ... Com. Dab, ... Lemon Dab, .. Grey Gurnard, ..	21 9 2 .. 1 ..	.. .. .. 2 .. 14	21 9 2 2 1 14	Net got split. Sandy bottom.
									33	16	49	
ame ality.	Oct. 10.		..	..	24	12.20 a.m.	4.20 a.m.	Haddock, ... Whiting, ... Com. Dab, ... Long Rough Dab, Grey Gurnard, ..	29 19 18	.. 9 7 5 96	29 28 25 5 96	Sand and mud.
									66	117	183	
loray h, off beath, from Ness; from sdale. led S. ircled wards , and n N.	Oct. 10.	..	52·0	52·5	25	1.10 p.m.	2.10 p.m.	Cod, ... Codling, ... Haddock, ... Whiting, ... Plaice, ... Lemon Dab, .. Com. Dab, ... Poor-cod, ...	3 5 273 16 15 5	.. .. 9 .. .. .. 5 59	3 5 282 16 15 5 5 59	Soft bottom.
									317	73	390	
same ality.	Oct. 10.	..	..	..	25	2.43 p.m.	7.5 p.m.	Codling, ... Haddock, ... Whiting, ... Halibut, ... Plaice, ... Lemon Dab, .. Com. Dab, ... Long Rough Dab, .. Grey Gurnard, .. Dragonet, ... *Agonus cataphractus*, .. Grey Skate, .. Sandy-ray, .. Thornback, .. Angler, ...	24 576 40 1 46 266 .. .. 1 1 1 ..	.. .. 47 119 1 116 1 3 7	24 576 40 1 46 313 119 1 116 1 3 1 1 1 7	10 edible crabs. 109 squids.
									956	294	1250	

TRAWLING INVESTIGATIONS.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
10. Moray Firth, off Dunbeath, S.W. from Clyth Ness; due E. from Helmsdale. Trawled S. and circled in towards shore, and then N.	1900. Oct. 10.	..	..	..	22 to 27	7.20 p.m.	11.20 p.m.	Codling, ...	39	..	39	One of the boards was after hauli have been flat. 80 squids.
								Haddock, ...	296	..	296	
								Whiting, ...	15	..	15	
								Plaice, ...	19	..	19	
								Lemon Dab, ..	69	15	84	
								Com. Dab, ...	..	14	14	
								Grey Gurnard, ..	..	26	26	
								Angler, ...	..	2	2	
									438	57	495	
11. Same Locality.	Oct. 10 and 11.	..	..	..	,,	11.55 p.m.	4.5 a.m.	Codling, ...	40	2	42	48 squids. 47 edible cr
								Hake, ...	1	..	1	
								Haddock, ...	254	6	260	
								Whiting, ...	51	5	56	
								Plaice, ...	38	..	38	
								Lemon Dab, ..	313	54	367	
								Com. Dab, ...	..	35	35	
								Sail-fluke, ...	..	1	1	
								Long Rough Dab	..	1	1	
								Grey Gurnard, ..	..	66	66	
								Red Gurnard, ..	..	1	1	
								Agonus, ...	..	1	1	
								Thornback, ..	4	1	5	
								Angler, ...	..	9	9	
									701	182	883	
12. Same Locality.	Oct. 11.	..	..	..	,,	5.10 a.m.	9.10 a.m.	Codling, ...	42	..	42	52 squids. 1 edible crab
								Ling, ...	1	..	1	
								Haddock, ...	209	2	211	
								Whiting, ...	27	..	27	Strong W wind; sea r
								Plaice, ...	41	..	41	
								Lemon Dab, ..	219	30	249	
								Sail-fluke, ...	2	..	2	
								Com. Dab, ...	..	50	50	
								Poor-cod, ...	..	2	2	
								Agonus, ...	..	1	1	
								Grey Gurnard, ..	..	38	38	
								Angler, ...	..	3	3	
									541	126	667	
13. Dornoch Firth, opposite Dunrobin Castle, towards Dornoch Bar.	Oct. 11.	..	52	52·6	8 to 12	2.30 p.m.	3.30 p.m.	Codling, ...	2	..	2	1 edible crab
								Plaice, ...	193	140	333	
								Lemon Dab, ..	1	2	3	
								Com. Dab, ...	..	606	606	
								Grey Gurnard, ..	..	38	38	
								Poor-cod, ...	..	1	1	
								Thornback, ..	..	2	2	
									196	789	985	
14. Dornoch Firth, off Dunrobin Castle, and towards S.	Oct. 11.	..	..	..	,,	4.15 p.m.	8.15 p.m.	Haddock, ...	1	..	1	1 edible crab
								Whiting, ...	..	1	1	
								Plaice, ...	595	232	827	
								Lemon Dab, ..	1	..	1	
								Com. Dab, ...	51	815	866	
								Grey Gurnard, ..	..	145	145	
								Thornback, ..	2	2	4	
									650	1195	1845	

TRAWLING INVESTIGATIONS.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
Dornoch rth, off nrobin tle, and ards S.	1900. Oct. 11 and 12.	..	..	..	8 to 12	8.45 p.m.	1.10 a.m.	Codling, ...	2	..	2	Trawl got on hard ground, and net slightly torn. Many edible crabs.
								Saithe, ...	1	..	1	
								Haddock, ...	42	1	43	
								Whiting, ...	2	..	2	
								Plaice, ...	573	305	878	
								Lemon Dab, ..	3	..	3	
								Com. Dab, ...	77	1116	1193	
								Grey Gurnard, ..	..	220	220	
								Thornback, ..	7	8	15	
								Angler, ...	..	3	3	
									707	1653	2360	
. Same cality.	Oct. 12.	..	..	..	,,	2.0 a.m.	6.0 a.m.	Codling, ...	1	..	1	
								Plaice, ...	182	199	381	
								Com. Dab, ...	..	285	285	
								Thornback, ..	2	3	5	
								Grey Gurnard, ..	..	255	255	
									185	742	927	
7. Off nbeath, before.	Oct. 12.	..	..	..	24	9.10 a.m.	1.10 p.m.	Cod, ...	3	..	3	
								Codling, ...	14	2	16	
								Hake, ...	2	..	2	
								Haddock, ...	624	7	631	
								Whiting, ...	40	..	40	
								Plaice, ...	47	..	47	
								Lemon Dab, ..	80	8	88	
								Halibut, ...	1	..	1	
								Com. Dab, ...	..	41	41	
								Grey Gurnard, ..	..	107	107	
								Mackerel, ...	..	1	1	
								Poor-cod, ...	..	2	2	
								Thornback, ..	3	4	7	
								Angler, ...	..	1	1	
									814	173	987	
. Aber- n Bay, off rburgh.	Oct. 13.	..	..	..	8 to 18	1.0 a.m.	2.0 a.m.	Codling, ...	4	..	4	
								Hake, ...	1	..	1	
								Haddock, ...	493	3	496	
								Whiting, ...	125	13	138	
								Plaice, ...	27	..	27	
								Com. Dab, ...	65	113	178	
								Thornback, ..	1	1	2	
									716	130	846	
7½ miles log N.E. Buchan Ness.	Oct. 15.	..	10·5	8·0	63	5.15 p.m.	7.15	Cod, ...	2	..	2	Steam trawler "St. Andrew." Wind W.; strong breeze.
								Codling, ...	2	..	2	
								Ling, ...	1	..	1	
								Tusk, ...	1	..	1	
								Hake, ...	1	1	2	
								Haddock, ...	58	1	59	
								Whiting, ...	65	..	65	
								Lemon Dab, ..	1	..	1	
								Witches, ...	34	..	34	
								Sail-fluke, ...	13	..	13	
								Long Rough Dab,	..	1	1	
								Grey Skate, ..	2	..	2	
								Starry-ray, ..	..	1	1	
									180	4	184	

F .. .. ..

TRAWLING INVESTIGATIONS.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remark
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
	1900.											
2. 87½ miles by log N.E. of Buchan Ness.	Oct. 12 and 13.	..	..	..	63	8.15 p.m.	1.15 a.m.	Cod, ...	8	..	8	
								Codling, ...	6	..	6	
								Ling, ...	1	..	1	
								Tusk, ...	3	..	3	
								Saithe, ...	1	..	1	
								Haddock, ...	215	..	215	
								Whiting, ...	21	..	21	
								Witches, ...	51	..	51	
								Sail-fluke, ...	12	..	12	
								Halibut, ...	2	..	2	
								Plaice, ...	1	..	1	
								Grey Skate, ..	1	..	1	
									322	..	322	
3. 97 miles N.E. of Buchan Ness.	Oct. 13.	..	..	..	81	2.45 a.m.	6.45 a.m.	Cod, ...	9	..	9	Weather stormy, and forced to Fair Isle, then to Le
								Codling, ...	3	..	3	
								Ling, ...	1	..	1	
								Hake, ...	4	..	4	
								Saithe, ...	1	..	1	
								Haddock, ...	612	9	621	
								Whiting, ...	..	1	1	
								Witches, ...	162	4	166	
								Sail-fluke, ...	26	..	26	
								Long Rough Dab,	..	19	19	
									818	33	851	
4. 34½ miles S. by W. from Bressay Lighthouse; Fair Isle bearing N.W. by W.	Oct. 16.	..	10·0	10·0	65	12.45 p.m.	2.15 p.m.	Cod, ...	1	..	1	
								Codling, ...	26	..	26	
								Hake, ...	17	..	17	
								Haddock, ...	575	31	606	
								Whiting, ...	172	..	172	
								Plaice, ...	6	..	6	
								Lemon Dab, ..	1	..	1	
								Sail-fluke, ...	5	2	7	
								Com. Dab, ...	..	8	8	
								Long Rough Dab,	..	37	37	
								Grey Gurnard, ..	..	4	4	
								Argentine, ..	..	1	1	
								Grey Skate, ..	1	..	1	
								Picked-dog, ..	..	3	3	
								Angler, ...	..	1	1	
									804	87	891	
5. Same Locality.	Oct. 16.	..	..	..	,,	2.45 p.m.	7.15 p.m.	Cod, ...	8	..	8	
								Codling, ...	39	1	40	
								Ling, ...	8	..	8	
								Hake, ...	20	..	20	
								Tusk, ...	2	..	2	
								Haddock, ...	1195	21	1216	
								Whiting, ...	..	1	1	
								Plaice, ...	14	..	14	
								Lemon Dab, ..	12	1	13	
								Witches, ...	42	1	43	
								Sail-fluke, ...	48	7	55	
								Com. Dab, ...	..	55	55	
								Long Rough Dab,	..	191	191	
								Grey Gurnard, ..	..	1	1	
								Grey Skate, ..	1	1	2	
								Starry-ray, ..	1	3	4	
								White Skate, ..	5	..	5	
								Picked-dog, ..	..	6	6	
								Angler, ...	..	4	4	
									1395	293	1688	

TRAWLING INVESTIGATIONS.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Over-board.	Total No.	
	1900.											
34½ miles by W. mBressay ighthouse; Fair Isle bearing W. by W.	Oct. 16 and 17.	..	..	..	65	7.45 p.m.	12.45 a.m.	Cod, ...	12	..	12	
								Codling, ...	37	1	38	
								Ling, ...	2	..	2	
								Hake, ...	13	..	13	
								Tusk, ...	4	..	4	
								Haddock, ...	823	2	825	
								Plaice, ...	19	..	19	
								Halibut, ...	1	..	1	
								Lemon Dab, ..	10	2	12	
								Witches, ...	20	..	20	
								Sail-fluke, ...	44	6	50	
								Com. Dab, ...	..	31	31	
								Long Rough Dab,	..	112	112	
								Poor-cod, ...	..	1	1	
								Norway Haddock,	..	1	1	
								White Skate, ..	7	..	7	
								Grey Skate, ..	7	..	7	
								Starry-ray, ..	3	5	8	
								Picked-dog, ..	..	5	5	
								Angler, ...	..	5	5	
									1002	171	1173	
. Same ocality.	Oct. 17.	..	..	..	,,	1.25 a.m.	6.25 a.m.	Cod, ...	4	..	4	Net got partly split.
								Codling, ...	40	4	44	
								Tusk, ...	1	..	1	
								Hake, ...	14	..	14	
								Ling, ...	1	..	1	
								Haddock, ...	744	29	773	
								Whiting, ...	128	3	131	
								Halibut, ...	3	..	3	
								Plaice, ...	18	..	18	
								Lemon Dab, ..	13	5	18	
								Witches, ...	10	2	12	
								Sail-fluke, ...	40	10	50	
								Com. Dab, ...	..	84	84	
								Grey Skate, ..	..	3	3	
								Starry-ray, ..	..	8	8	
								White Skate, ..	2	..	2	
								Argentine, ..	..	1	1	
								Long Rough Dab,	..	188	188	
								Picked-dog, ..	..	2	2	
								Angler, ...	..	14	14	
									1018	353	1371	
. Same ocality.	Oct. 17.	..	..	..	,,	7.30 a.m.	12.30 p.m.	Cod, ...	9	..	9	
								Codling, ...	71	..	71	
								Ling, ...	2	..	2	
								Saithe, ...	1	..	1	
								Hake, ...	45	..	45	
								Haddock, ...	992	6	998	
								Whiting, ...	119	..	119	
								Halibut, ...	4	..	4	
								Plaice, ...	23	..	23	
								Sail-fluke, ...	22	3	25	
								Witches, ...	24	2	26	
								Lemon Dab, ..	20	..	20	
								Com. Dab, ...	..	52	52	
								Long Rough Dab,	..	152	152	
								Grey Gurnard, ..	..	6	6	
								Poor-cod, ...	..	5	5	
								Cat-fish, ...	1	..	1	
								White Skate, ..	3	..	3	
								Starry-ray, ..	..	9	9	
								Picked-dog, ..	..	3	3	
								Angler, ...	..	1	1	
									1336	239	1575	

TRAWLING INVESTIGATIONS.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
9. 34½ miles S. by W. from Bressay Lighthouse; Fair Isle bearing N.W. by W.	Oct. 17.	..	..	..	65	1.0 p.m.	6.0 p.m.	Cod,	2	..	2	
								Codling,	74	..	74	
								Ling,	3	..	3	
								Hake,	34	..	34	
								Tusk,	1	..	1	
								Saithe,	1	..	1	
								Haddock,	892	2	894	
								Whiting,	69	..	69	
								Halibut,	1	..	1	
								Plaice,	26	..	26	
								Lemon Dab,	12	1	13	
								Witches,	32	2	34	
								Sail-fluke,	24	2	26	
								Com. Dab,	..	19	19	
								Long Rough Dab,	..	93	93	
								Grey Gurnard,	..	4	4	
								Poor-cod,	..	3	3	
								Norway Haddock,	..	1	1	
								Grey Skate,	1	..	1	
								Starry-ray,	..	1	1	
								Picked-dog,	..	6	6	
								Angler,	..	1	1	
									1172	135	1307	
10. Same Locality.	Oct. 17.	..	..	..	,,	6.30 p.m.	11.30 p.m.	Cod,	8	..	8	Net got split.
								Codling,	73	..	73	
								Ling,	2	..	2	
								Hake,	1	..	1	
								Tusk,	3	..	3	
								Saithe,	2	..	2	
								Haddock,	469	1	470	
								Whiting,	28	1	29	
								Halibut,	4	..	4	
								Plaice,	12	..	12	
								Lemon Dab,	5	..	5	
								Witches,	36	2	38	
								Sail-fluke,	17	2	19	
								Com. Dab,	..	10	10	
								Long Rough Dab,	..	61	61	
								Grey Gurnard,	..	1	1	
								Cat-fish,	1	1	2	
								Grey Skate,	2	5	7	
								Starry-ray,	..	6	6	
								Picked-dog,	..	1	1	
								Angler,	..	6	6	
									663	97	760	
11. Same Locality.	Oct. 18.	..	..	..	,,	12.15 a.m.	5.15 a.m.	Cod,	11	..	11	
								Codling,	60	3	63	
								Ling,	4	..	4	
								Tusk,	2	..	2	
								Hake,	7	..	7	
								Saithe,	14	..	14	
								Lythe,	1	..	1	
								Haddock,	886	23	909	
								Whiting,	74	..	74	
								Brassie,	..	1	1	
								Halibut,	5	..	5	
								Plaice,	10	..	10	
								Lemon Dab,	11	1	12	
								Witches,	34	2	36	
								Sail-fluke,	21	7	28	
								Com. Dab,	..	18	18	
								Long Rough Dab,	..	111	111	
								Grey Skate,	1	5	6	
								Starry-ray,	..	18	18	
								White Skate,	6	..	6	
								Picked-dog,	..	1	1	
								Angler,	..	6	6	
									1147	196	1343	

TRAWLING INVESTIGATIONS.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
	1900.											
34½ miles by W. a Bressay hthouse; ir Isle earing W., and mburgh ad bear- N.N.E. ½ N.	Oct. 18.	..	..	..	65	6.5 a.m.	11.5 a.m.	Cod, ...	5	..	5	
								Codling, ...	45	..	45	
								Ling, ...	26	..	26	
								Tusk, ...	6	..	6	
								Hake, ...	26	..	26	
								Saithe, ...	3	..	3	
								Haddock, ...	1410	38	1448	
								Whiting, ...	634	9	643	
								Halibut, ...	1	..	1	
								Plaice, ...	10	..	10	
								Lemon Dab, ..	12	4	16	
								Witches, ...	99	2	101	
								Sail-fluke, ...	44	14	58	
								Com. Dab, ..	..	139	139	
								Long Rough Dab,	..	683	683	
								Grey Gurnard, ..	..	20	20	
								Norway Haddock,	..	3	3	
								Cat-fish, ...	3	..	3	
								Grey Skate, ..	2	..	2	
								White Skate, ..	2	..	2	
								Picked-dog, ..	..	2	2	
								Angler, ...	..	1	1	
									2328	915	3243	
. Same ality; at m. Fair e bear- g N.W. V., and mburgh ad N. ¼ E.	Oct. 18.	..	..	..	,,	11.40 a.m.	4.40 p.m.	Cod, ...	15	..	15	
								Codling, ...	29	..	29	
								Ling, ...	68	..	68	
								Tusk, ...	3	..	3	
								Hake, ...	35	..	35	
								Saithe, ...	1	..	1	
								Haddock, ...	1125	14	1139	
								Whiting, ...	481	2	483	
								Halibut, ...	1	..	1	
								Plaice, ...	8	..	8	
								Lemon Dab, ..	5	5	10	
								Witches, ...	29	2	31	
								Sail-fluke, ...	40	10	50	
								Com. Dab, ...	..	129	129	
								Long Rough Dab,	..	368	368	
								Poor-cod, ...	..	1	1	
								Gurnard, ...	..	19	19	
								Cat-fish, ...	2	..	2	
								Grey Skate, ..	1	..	1	
								White Skate, ..	4	..	4	
								Starry-ray, ..	..	2	2	
								Angler, ...	..	1	1	
									1847	553	2400	
. Same cality.	Oct. 18.	..	..	..	,,	5.10 p.m.	10.0 p.m.	Cod, ...	2	..	2	
								Codling, ...	62	4	66	
								Ling, ...	1	..	1	
								Hake, ...	6	..	6	
								Saithe, ...	5	..	5	
								Haddock, ...	415	7	422	
								Whiting, ...	162	3	165	
								Halibut, ...	1	..	1	
								Plaice, ...	7	..	7	
								Lemon Dab, ..	16	2	18	
								Witches, ...	34	6	40	
								Sail-fluke, ...	26	12	38	
								Com. Dab, ...	..	72	72	
								Long Rough Dab,	..	211	211	
								Cat-fish, ...	1	..	1	
								Grey Gurnard, ..	..	3	3	
								Norway Haddock,	..	1	1	
								Poor-cod, ...	..	3	3	
								Grey Skate, ..	..	4	4	
								Starry-ray, ..	..	8	8	
								White Skate, ..	2	..	2	
								Picked-dog, ..	..	1	1	
								Angler, ...	..	4	4	
									740	341	1081	

TRAWLING INVESTIGATIONS.

Place.	Date	Temperature. Air.	Surface.	Bottom.	Depth in Fms.	Time Trawl Down. Shot.	Hauled.	Fish Caught. Name.	No. taken to Market.	No. thrown Overboard.	Total No.	Remarks
15. 3½ miles S. by W. from Bressay Lighthouse at 2 p.m.; Fair Isle bearing N.W. ¼ W., and Sumburgh Head N. ¼ E.	1900. Oct. 18 and 19.	..	..	..	65	10.40 p.m.	3.30 a.m.	Cod,	9	..	9	
								Codling,	29	2	31	
								Ling,	6	..	6	
								Hake,	5	..	5	
								Haddock,	645	3	648	
								Whiting,	96	..	96	
								Halibut,	3	..	3	
								Plaice,	10	..	10	
								Lemon Dab,	9	..	9	
								Witches,	56	3	59	
								Sail-fluke,	19	7	26	
								Com. Dab,	..	33	33	
								Long Rough Dab,	..	122	122	
								Grey Gurnard,	..	1	1	
								Grey Skate,	4	2	6	
								White Skate,	3	..	3	
								Starry-ray,	..	3	3	
								Angler,	..	3	3	
									894	179	1073	
16. Same Locality; Fair Isle bearing N.W. ¼ N. Light visible on horizon, about 17 or 18 miles.	Oct. 19.	..	..	..	66	4.20 a.m.	9.20 a.m.	Cod,	8	..	8	
								Codling,	22	..	22	
								Ling,	14	..	14	
								Tusk,	4	..	4	
								Hake,	27	..	27	
								Haddock,	1073	9	1082	
								Whiting,	321	2	323	
								Plaice,	6	..	6	
								Lemon Dab,	6	3	9	
								Witches,	46	6	52	
								Sail-fluke,	40	15	55	
								Com. Dab,	..	47	47	
								Long Rough Dab,	..	414	414	
								Poor-cod,	..	1	1	
								Cat-fish,	1	..	1	
								Grey Gurnard,	..	6	6	
								Grey Skate,	5	..	5	
								White Skate,	1	..	1	
								Starry-ray,	..	8	8	
								Argentine,	..	1	1	
								Herring,	..	2	2	
								Angler,	..	1	1	
									1574	515	2089	
17. Same Locality.	Oct. 19.	..	10·2	7·9	66	10.30 a.m.	12 Noon.	Cod,	1	..	1	
								Codling,	8	..	8	
								Ling,	1	..	1	
								Hake,	8	..	8	
								Haddock,	291	3	294	
								Whiting,	176	..	176	
								Halibut,	1	..	1	
								Plaice,	1	..	1	
								Lemon Dab,	1	1	2	
								Witches,	4	..	4	
								Sail-fluke,	18	6	24	
								Com. Dab,	..	7	7	
								Long Rough Dab,	..	108	108	
								Norway Haddock,	..	2	2	
								Angler,	..	1	1	
									510	128	638	

TRAWLING INVESTIGATIONS.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Over-board.	Total No.	
4½ miles by W. Bressay thouse; ir Isle aring V. ¼ N. t visible iorizon, at 17 or miles.	1900. Oct. 19.	..	..	..	66	12.30 p.m.	5.30 p.m.	Cod, ...	14	..	14	
								Codling, ...	13	..	13	
								Ling, ...	32	..	32	
								Tusk, ...	3	1	4	
								Hake, ...	42	..	42	
								Saithe, ...	1	..	1	
								Haddock, ...	1197	11	1208	
								Whiting, ...	444	..	444	
								Halibut, ...	2	..	2	
								Plaice, ...	5	..	5	
								Lemon Dab, ..	1	1	2	
								Witches, ...	58	12	70	
								Sail-fluke, ...	46	18	64	
								Com. Dab, ...	..	32	32	
								Long Rough Dab,	..	305	305	
								Grey Gurnard, ..	..	12	12	
								Grey Skate, ..	5	..	5	
								Starry-ray, ..	..	3	3	
									1863	395	2258	
Same quality.	Oct. 19.	..	..	..	,,	6.35 p.m.	11.5 p.m.	Cod, ...	12	..	12	Net badly torn.
								Codling, ...	6	..	6	
								Ling, ...	2	..	2	
								Tusk, ...	5	..	5	
								Saithe, ...	15	..	15	
								Lythe, ...	5	..	5	
								Haddock, ...	426	3	429	
								Whiting, ...	48	1	49	
								Halibut, ...	2	..	2	
								Plaice, ...	5	..	5	
								Witches, ...	14	2	16	
								Sail-fluke, ...	22	7	29	
								Com. Dab, ...	..	8	8	
								Long Rough Dab,	..	52	52	
								Brassie, ...	..	1	1	
								Norway Haddock,	..	1	1	
								Grey Skate, ..	3	1	4	
								White Skate, ..	1	..	1	
								Starry-ray, ..	..	2	2	
								Picked-dog, ..	..	1	1	
								Angler, ...	..	2	2	
									566	81	647	
Same quality.	Oct. 20.	..	..	..	,,	12.30 a.m.	5.30 a.m.	Cod, ...	15	..	15	
								Ling, ...	5	..	5	
								Tusk, ...	2	..	2	
								Hake, ...	4	..	4	
								Saithe, ...	2	..	2	
								Haddock, ...	657	..	657	
								Whiting, ...	50	..	50	
								Halibut, ...	6	..	6	
								Plaice, ...	6	..	6	
								Lemon Dab, ..	8	..	8	
								Witches, ...	176	10	186	
								Sail-fluke, ...	38	3	41	
								Com. Dab, ...	..	1	1	
								Long Rough Dab,	..	21	21	
								Poor-cod, ...	..	3	3	
								Argentine, ...	..	1	1	
								Norway Haddock,	..	2	2	
								Grey Skate, ..	4	..	4	
								White Skate, ..	2	..	2	
								Starry-ray, ..	..	12	12	
								Picked-dog, ..	..	1	1	
								Angler, ...	..	1	1	
									975	55	1030	

TRAWLING INVESTIGATIONS.

Place	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remark
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
21. 34½ miles S. by W. from Hessay Lighthouse; Fair Isle bearing N.W. ¼ W. Light visible on horizon, about 17 or 18 miles.	Oct. 20.	..	..	..	66	6.40 a.m.	10.40 a.m.	Haddock, ...	419	..	419	The quantity was so grea the cod-end outside the probable about 30 b mostly had or, say, abou fish.
								Whiting, ...	57	1	58	
								Lemon Dab, ..	3	..	3	
								Witches, ...	68	2	70	
								Sail-fluke, ...	24	2	26	
								Com. Dab, ...	..	6	6	
								Long Rough Dab,	..	20	20	
								Grey Gurnard, ..	..	1	1	
								Starry-ray, ..	..	4	4	
								Angler, ...	..	1	1	
									571	37	608	
22. Same Locality.	Oct. 20.	..	..	..	,,	11.30 a.m.	4.30 p.m.	Cod, ...	12	..	12	
								Codling, ...	18	1	19	
								Ling, ...	22	..	22	
								Tusk, ...	2	..	2	
								Hake, ...	25	..	25	
								Saithe, ...	1	..	1	
								Haddock, ...	816	12	828	
								Whiting, ...	379	1	380	
								Halibut, ...	4	..	4	
								Plaice, ...	6	..	6	
								Lemon Dab, ..	8	..	8	
								Witches, ...	31	20	51	
								Sail-fluke, ...	30	4	34	
								Com. Dab, ...	..	7	7	
								Long Rough Dab,	..	96	96	
								Cat-fish, ...	1	..	1	
								Grey Skate, ..	1	1	2	
								Starry-ray, ..	.	3	3	
								Picked-dog, ..	..	1	1	
								Angler, ...	..	1	1	
									1356	147	1503	
23. Same Locality. Distance by log from Buchan Ness 120 miles N.E. by N. N. light on Fair Isle bearing N.W. ¼ N., probable distance 25 miles.	Oct. 20.	..	..	..	,,	5.25 p.m.	10.0 p.m.	Cod, ...	10	..	10	This was th southern worked on fishing 10.45 p.m. arrived Ness 10.40 21st Octob
								Codling, ...	10	..	10	
								Ling, ...	8	..	8	
								Hake, ...	5	..	5	
								Saithe, ...	1	..	1	
								Haddock, ...	1110	8	1118	
								Whiting, ...	162	..	162	
								Plaice, ...	1	..	1	
								Lemon Dab, ..	2	..	2	
								Witches, ...	208	4	212	
								Sail-fluke, ...	23	3	26	
								Com. Dab, ...	..	4	4	
								Long Rough Dab,	..	104	104	
								White Skate, ..	4	..	4	
								Grey Skate, ..	1	..	1	
								Starry-ray, ..	..	1	1	
								Grey Gurnard, ..	..	1	1	
								Poor-cod, ...	..	1	1	
								Argentine, ..	..	1	1	
								Picked-dog, ..	..	1	1	
								Angler, ...	..	2	2	
									1545	130	1675	

TRAWLING INVESTIGATIONS.

ace.	Date.	Temperature. Air.	Surface.	Bottom.	Depth in Fms.	Time Trawl Down. Shot.	Hauled.	Fish Caught. Name.	No. taken to Market.	No. thrown Overboard.	Total No.	Remarks.
ber- Bay. oppo- Coast- ard tion ards k Dog sweep E.	1900. Oct. 31.	9·4	9·2	9·4	8 to 10	11.28 a.m.	12.28 p.m.	Codling, ... Haddock, ... Whiting, ... Plaice, ... Lemon Dab, .. Com. Dab, ... Flounders, .. Long Rough Dab, Dragonet, ...	6 38 30 307 3 172 4	.. 5 9 7 2 469 6 1 1	6 43 39 314 5 641 10 1 1	"St. Andrew," Slight sea; wind S. by E.; smart breeze.
									560	500	1060	
ber- Bay. New- gh in ps for miles rth- rds.	Oct. 31.	..	..	..	7 to 16	1.15 p.m.	4.15 p.m.	Codling, ... Haddock, ... Whiting, ... Turbot, ... Black Sole, .. Plaice, ... Lemon Dab, .. Com. Dab, ... Flounder, ... Long Rough Dab, Grey Gurnard, .. Grey Skate, ..	41 3886 15 1 1 214 .. 1243 75	1 5 16 .. .. 3 7 1218 2 1 3 3	42 3891 31 1 1 217 7 2461 77 1 3 3	Heavy sea from S.S.E.
									5476	1259	6735	
Aber- Bay. ween k Dog Bel- lvie use.	Nov. 1.	12·1	10·2	9·8	12 to 15	4.43 p.m.	5.43 p.m.	Codling, ... Hake, ... Haddock, ... Whiting, ... Plaice, ... Lemon Dab, .. Com. Dab, .. Long Rough Dab, Grey Gurnard, .. Starry-ray, .. Angler, ...	1 1 764 14 125 6 439	.. .. .. 31 .. .. .. 3 1 4 7	1 1 764 45 125 6 439 3 1 4 7	
									1350	46	1396	
Aber- Bay. eps off burgh miles h of it.	Nov. 1.	..	..	..	8 to 18	6.30 p.m.	7.50 p.m.	Cod, ... Haddock, ... Whiting, ... Halibut, ... Plaice, ... Com. Dab, ... Starry-ray, ..	1 550 32 1 181 128 ..	.. .. 22 .. .. 202 3	1 550 54 1 181 330 3	Net caught and brought up.
									893	227	1120	
Same ality.	Nov. 1.	..	..	..	13 to 19	8.25 p.m.	11.25 p.m.	Codling, ... Haddock, ... Whiting, ... Halibut, ... Plaice, ... Com. Dab, .. Long Rough Dab, Grey Gurnard, .. Starry-ray, .. Angler, ...	.. 1727 143 .. 260 1110	1 .. 15 1 .. 230 2 12 2 6	1 1727 158 1 260 1340 2 12 2 6	Of the haddocks 111 were "firsts," 98 were "seconds," and the rest "thirds" or "chats."
									3240	269	3509	

TRAWLING INVESTIGATIONS.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
6. Aberdeen Bay. Sweeps off Newburgh and 3 miles north of it.	1900. Nov. 1 and 2.	..	..	..	10 to 18	11.55 p.m.	2.5 a.m.	Cod, ...	2	*	*	* Those th overboard, c dabs, were enumerated the hadd 186 were "fi 239 "seco and the "thirds."
								Codling, ...	1	..	..	
								Haddock, ...	2273	..	..	
								Whiting, ...	532	..	..	
								Plaice, ...	201	..	.	
								Com. Dab, ...	1099	..	..	
									4108	..	..	
7. Moray Firth. About 30 miles W. of Kinnaird Head and about 12 miles off land. Covesea Light seen due W. at 1.30 a.m.	Nov. 3.	..	..	..	50	12.30 a.m.	4.30	Cod, ...	8	..	8	Winch broke and bag no in until 7.3 56 *Nephrops* edible crab
								Codling, ...	5	1	6	
								Ling, ...	2	..	2	
								Hake, ...	21	1	22	
								Haddock, ...	331	3	334	
								Whiting, ...	97	4	101	
								Plaice, ...	3	..	3	
								Lemon Dab, ..	2	4	6	
								Witches, ...	327	33	360	
								Common Dab, ..	65	137	202	
								Long Rough Dab,	..	431	431	
								Grey Gurnard, ..	..	8	8	
								Grey Skate, ..	20	3	23	
								Thornback, ..	2	2	4	
								Starry-ray, ..	..	2	2	
								Picked-dog, ..	..	3	3	
								Angler, ...	..	23	23	
									883	655	1538	
8. Moray Firth. 3 miles off Lossiemouth, trawling around a dan.	Nov. 3.	11·8	9·7	9·9	11 to 15	11.10 a.m.	12.55 p.m.	Cod, ...	1	..	1	5 squids.
								Codling, ...	..	1	1	
								Haddock, ...	11	..	11	
								Turbot, ...	1	..	1	
								Plaice, ...	162	1	163	
								Lemon Dab, ..	7	..	7	
								Com. Dab, ..	52	118	170	
								Long Rough Dab,	..	12	12	
								Grey Gurnard, ..	..	153	153	
								Norway Pout, ..	..	2	2	
								Cuckoo-ray, ..	1	..	1	
								Thornback, ..	2	..	2	
								Angler, ...	..	2	2	
									237	289	526	
9. Moray Firth. Same place.	Nov. 3.	..	..	..	,,	1.10 p.m.	2.50 p.m.	Cod, ...	1	..	1	Trawl caugh bottom.
								Codling, ...	3	1	4	
								Haddock, ...	4	1	5	
								Whiting, ...	..	1	1	
								Plaice, ...	79	2	81	
								Lemon Dab, ..	4	..	4	
								Com. Dab, ...	28	80	108	
								Long Rough Dab,	..	2	2	
								Grey Gurnard, ..	..	421	421	
								Thornback, ..	1	2	3	
								Starry-ray, ..	..	1	1	
									120	511	631	

TRAWLING INVESTIGATIONS.

Place.	Date.	Temperature. Air.	Surface.	Bottom.	Depth in Fms.	Time Trawl Down. Shot.	Hauled.	Fish Caught. Name.	No. taken to Market.	No. thrown Overboard.	Total No.	Remarks.
Moray th, same ce, but reling ıser in, de dan, ding E.) as to ut out ıvesea ht, and a sweep r round W.	1900. Nov. 3.	..	..	..	7 to 10.	3.30 p.m.	7.30 p.m.	Cod, ...	9	..	9	
								Codling, ...	..	2	2	
								Haddock, ...	7	..	7	
								Whiting, ...	..	1	1	
								Brill, ...	3	..	3	
								Plaice, ...	238	43	281	
								Lemon Dab, ..	8	2	10	
								Com. Dab, ...	273	364	637	
								Flounder, ...	2	..	2	
								Grey Gurnard, ..	..	398	398	
								Allis Shad, ...	..	1	1	
								Thornback, ..	5	1	6	
								Angler, ...	..	6	6	
									545	818	1363	
Same cality.	Nov. 3 and 4.	..	..	..	,,	8.15 p.m.	12.30 a.m.	Cod, ...	4	..	4	90 edible crabs (small).
								Haddock, ...	41	..	41	
								Turbot, ...	2	..	2	
								Brill, ...	1	..	1	
								Plaice, ...	156	2	158	
								Lemon Dab, ..	4	3	7	
								Com. Dab, ...	72	557	629	
								Little Sole, ..	..	1	1	
								Grey Gurnard, ..	..	399	399	
								Thornback, ..	3	1	4	
								Angler, ...	1	..	1	
									284	963	1247	
Same cality.	Nov. 4.	..	9·4	10·0	,,	12.55 a.m.	5·0 a.m.	Cod, ...	5	..	5	23 edible crabs (small).
								Haddock, ...	2	1	3	
								Whiting, ...	1	..	1	
								Conger, ...	2	..	2	
								Turbot, ...	1	..	1	
								Brill, ...	2	..	2	
								Plaice, ...	255	6	261	
								Lemon Dab, ..	6	3	9	
								Com. Dab, ...	63	719	782	
								Grey Gurnard, ..	..	238	238	
								Thornback, ..	3	3	6	
								Angler, ...	..	2	2	
									340	972	1312	
Moray 'irth. bet Ness ht N.W. ., Cove- S.S.E., shore ɔmarty rth W. ., steer- towards arbet Ness.	Nov. 4.	..	9·5	10·4	20	8.32 a.m.	10.25 a.m.	Cod, ...	4	..	4	Trawl became fast. 12 squids, 2 edible crabs.
								Codling, ...	18	..	18	
								Haddock, ...	102	..	102	
								Whiting, ...	29	..	29	
								Plaice, ...	26	..	26	
								Lemon Dab, ..	6	..	6	
								Brill, ...	1	..	1	
								Com. Dab, ..	..	145	145	
								Long Rough Dab,	..	1	1	
								Grey Gurnard, ..	..	39	39	
								Norway Pout, ..	..	2	2	
									186	187	373	

TRAWLING INVESTIGATIONS.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
	1900.											
14. Dornoch Firth. Shot: Brora Point N.E., Dunrobin Castle N. Hauled: Embo W. ¼ N., Tarbet Lighthouse S.E. ¼ S.	Nov. 5.	..	9·2	9·8	7 to 10	8.30 a.m.	10.0 a.m.	Cod, ...	5	..	5	
								Codling, ...	2	..	2	
								Haddock, ...	12	..	12	
								Brill, ...	4	..	4	
								Plaice, ...	552	27	579	
								Lemon Dab, ..	5	..	5	
								Com. Dab, ...	135	9	144	
								Grey Gurnard, ..	..	8	8	
								Thornback, ..	5	..	5	
								Angler, ...	..	1	1	
									720	45	765	
15. Same Locality.	Nov. 5.	..	..	..	Average 10	11.33 a.m.	3.40 p.m.	Cod, ...	2	..	2	132 plaice "large," "medium," "small."
								Codling, ...	..	26	26	
								Haddock, ...	60	..	60	
								Whiting, ...	..	8	8	
								Brill, ...	3	..	3	
								Plaice, ...	1618	48	1666	
								Lemon Dab, ..	..	2	2	
								Com. Dab, ...	235	615	850	
								Grey Gurnard, ..	..	5	5	
								Thornback, ..	3	7	10	
								Angler, ...	..	1	1	
									1921	712	2633	
16. Same Locality.	Nov. 5.	..	..	..	Average 10	4.10 p.m.	8.10 p.m.	Cod, ...	3	..	3	15 baskets of Small plaice for market.
								Codling, ...	..	6	6	
								Haddock, ...	20	5	25	
								Whiting, ...	..	8	8	
								Brill, ...	1	..	1	
								Plaice, ...	1386	4	1390	
								Lemon Dab, ..	6	2	8	
								Com. Dab, ...	113	1941	2054	
								Solenette, ...	..	1	1	
								Grey Gurnard, ..	..	26	26	
								Dragonet, ...	..	1	1	
								Thornback, ..	1	9	10	
								Angler, ...	..	6	6	
									1530	2009	3539	
17. Same Locality.	Nov. 5 and 6.	..	..	..	,,	8.45 p.m.	12.45 a.m.	Cod, ...	4	..	4	
								Codling, ...	..	19	19	
								Haddock, ...	7	1	8	
								Whiting, ...	..	17	17	
								Brill, ...	7	..	7	
								Plaice, ...	1248	328	1576	
								Lemon Dab, ..	..	8	8	
								Com. Dab, ...	83	2230	2313	
								Grey Gurnard, ..	..	20	20	
								Thornback, ..	6	6	12	
								Grey Skate, ..	..	1	1	
								Cottus scorpius, ..	..	1	1	
								Agonus, ...	..	3	3	
								Porbeagle Shark,	..	1	1	
									1355	2635	3990	
18. Same Locality.	Nov. 6.	..	..	..	,,	1.35 a.m.	5.40 a.m.	Cod, ...	7	..	7	
								Codling, ...	2	6	8	
								Haddock, ...	14	..	14	
								Whiting, ...	..	6	6	
								Brill, ...	4	..	4	
								Plaice, ...	1358	333	1691	
								Lemon Dab, ..	..	9	9	
								Com. Dab, ...	69	2230	2299	
								Grey Gurnard, ..	..	11	11	
								Thornback, ..	..	16	16	
								Cottus scorpius, ..	..	1	1	
								Angler, ...	..	1	1	
									1454	2613	4067	

TRAWLING INVESTIGATIONS.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
Dornoch Firth. t: Brora int N.E., unrobin astle N. fauled: abo W. ½ , Tarbet ghthouse .E. ½ S.	1900. Nov. 6.	..	..	..	9 and 10	6.20 a.m.	10.30 a.m.	Cod, ...	1	..	1	17 baskets of plaice, 626 "large," 138 "medium," 1113 "small."
								Codling, ...	5	27	32	
								Haddock, ...	107	..	107	
								Whiting, ...	8	..	8	
								Halibut, ...	1	..	1	
								Brill, ...	8	..	8	
								Plaice, ...	1877	538	2415	
								Lemon Dab, ..	..	14	14	
								Com. Dab, ...	50	1127	1177	
								Grey Gurnard, ..	..	45	45	
								Thornback, ..	1	5	6	
								Herring, ...	..	6	6	
								Angler, ...	..	3	3	
									2058	1765	3823	
). Same ocality.	Nov. 6.	..	..	..	8 and 9	12.15 p.m.	4.20 p.m.	Cod, ...	3	..	3	
								Codling, ...	39	16	55	
								Haddock, ...	333	..	333	
								Whiting, ...	24	29	53	
								Brill, ...	3	..	3	
								Plaice, ...	1278	302	1580	
								Lemon Dab, ..	3	3	6	
								Com. Dab, ...	30	597	627	
								Grey Gurnard, ..	..	18	18	
								Thornback, ..	1	..	1	
								Herring, ...	..	51	51	
									1714	1016	2730	
1. Same ocality.	Nov. 6.	7·6	9·0	9·9	8 to 9	5.15 p.m.	6.10 p.m.	Cod, ...	1	..	1	
								Haddock, ...	1	..	1	
								Whiting, ...	1	..	1	
								Plaice, ...	158	..	158	
								Lemon Dab, ..	4	..	4	
								Com. Dab, ...	2	..	2	
								Grey Gurnard, ..	..	2	2	
									167	2	169	
2. Same ocality, it a little further outh towards the uth of the Dornoch.	Nov. 6.	..	..	..	8	6.30 p.m.	10.40 p.m.	Cod, ...	2	..	2	Marketable plaice, 280 "large," 218 "medium," 1003 "small."
								Codling, ...	..	5	5	
								Whiting, ...	..	8	8	
								Brill, ...	2	..	2	
								Plaice, ...	1501	355	1856	
								Lemon Dab, ..	..	4	4	
								Com. Dab, ...	53	1545	1598	
								Grey Gurnard, ..	..	24	24	
								Dragonet, ...	..	1	1	
								Thornback, ..	1	12	13	
								Angler, ...	..	1	1	
									1559	1955	3514	
Dornoch ay, N. of unrobin Castle.	Nov. 6 and 7.	..	..	..	9 to 11	11.10 p.m.	3.20 a.m.	Cod, ...	21	..	21	
								Codling, ...	303	22	325	
								Ling, ...	2	..	2	
								Saithe, ...	..	4	4	
								Haddock, ...	435	2	437	
								Whiting, ...	82	17	99	
								Halibut, ...	1	..	1	
								Brill, ...	2	..	2	
								Plaice, ...	813	63	876	
								Lemon Dab, ..	97	23	120	
								Com. Dab, ...	38	176	214	
								Grey Gurnard, ..	..	8	8	
								Thornback, ..	1	..	1	
									1795	315	2110	

TRAWLING INVESTIGATIONS.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Rema
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
24. Dornoch Bay, N. of Dunrobin Castle.	1900. Nov. 7.	....	.	..	9 to 11	4.50 a.m.	8.20 a.m.	Cod, ...	9	..	9	
								Codling, ...	26	27	53	
								Haddock, ...	166	..	166	
								Whiting, ...	9	18	27	
								Brill, ...	10	..	10	
								Plaice, ...	1215	269	1484	
								Lemon Dab, ..	12	12	24	
								Com. Dab, ...	128	1741	1869	
								Grey Gurnard, ..	..	32	32	
								Dragonet, ...	..	5	5	
								Poor-cod, ...	..	1	1	
								Thornback, ..	2	..	2	
									1577	2105	3682	
25. Same, Locality, going into 12 fathoms, with Castle bearing N.N.W.	Nov. 7.	..	..	..	9 to 12	8.50 a.m.	12.55 p.m.	Codling, ...	57	13	70	Got on ground, badly tor
								Haddock, ...	55	1	56	
								Whiting, ...	34	5	39	
								Brill, ...	5	..	5	
								Plaice, ...	499	84	583	
								Lemon Dab, ..	7	2	9	
								Com. Dab, ..	23	326	349	
								Grey Gurnard, ..	..	17	17	
									680	448	1128	
26. Same Locality.	Nov. 7.	..	..	..	,,	6.5 p.m.	10.15 p.m.	Cod, ...	8	..	8	
								Codling, ...	..	10	10	
								Haddock, ...	8	..	8	
								Whiting, ...	..	7	7	
								Plaice, ...	442	75	517	
								Lemon Dab, ..	1	1	2	
								Com. Dab, ..	30	526	556	
								Sail-fluke, ...	..	1	1	
								Grey Gurnard, ..	..	9	9	
								Grey Skate, ..	..	1	1	
								Thornback, ..	1	4	5	
									490	634	1124	
27. Same Locality.	Nov. 7 and 8.	....	..	..	,,	10.50 p.m.	2.55 a.m.	Cod, ...	7	..	7	
								Codling, ...	..	15	15	
								Haddock, ...	3	2	5	
								Whiting, ...	..	28	28	
								Brill, ...	12	..	12	
								Plaice, ...	1291	221	1512	
								Lemon Dab, ..	7	14	21	
								Sail-fluke, ...	2	..	2	
								Com. Dab, ...	83	1459	1542	
								Grey Gurnard, ..	..	16	16	
								Norway Pout, ..	..	1	1	
								Grey Skate, ..	..	1	1	
								Thornback, ..	..	2	2	
								Angler, ...	..	1	1	
									1405	1760	3165	
28. Moray Firth, east of Smith Bank; North Pap of Caithness bearing N.W. by W. ½ W., and clear north of large hill.	Nov. 8.	6·6	9·8	10·4	35	7.45 a.m.	8.30 a.m.	Codling, ...	..	1	1	Strong wind; m sea.
								Hake, ...	3	..	3	
								Haddock, ...	338	..	338	
								Whiting, ...	153	..	153	
								Plaice, ...	10	..	10	
								Lemon Dab, ..	8	11	19	
								Witches, ...	3	..	3	
								Sail-fluke, ...	..	1	1	
								Com. Dab, ...	..	99	99	
								Long Rough Dab,	..	15	15	
								Grey Gurnard, .	..	151	151	
								Grey Skate, ..	1	..	1	
								Thornback, ..	1	..	1	
								Angler, ...	..	2	2	
									517	280	797	

TRAWLING INVESTIGATIONS.

ɔe.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
ber- Bay. len to Dog ack.	1900. Nov. 8 and 9.	..	..	..	8 to 11.	Midnight.	5 a.m.	Cod, ...	31	..	31	
								Haddock, ...	62	1	63	
								Whiting, ...	..	12	12	
								Plaice, ...	205	4	209	
								Lemon Dab, ..	1	..	1	
								Com. Dab, ...	..	5	5	
								Grey Gurnard, ..	..	2	2	
								Starry-ray, ..	..	30	30	
								Grey Skate, ..	..	7	7	
									299	61	360	
ame lity, a.m. an ss ring S., N. l of urgh ds ¾ W.	Nov. 9.	..	..	..	15½	5.40 a.m.	8.45 a.m.	Cod, ...	4	..	4	
								Codling, ...	..	2	2	
								Haddock, ...	4	2	6	
								Whiting, ...	..	17	17	
								Plaice, ...	24	..	24	
								Lemon Dab, ..	1	..	1	
								Com. Dab, ...	..	26	26	
								Long Rough Dab,	..	8	8	
								Conger, ...	1	..	1	
								Starry-ray, ..	..	46	46	
								Thornback, ..	..	7	7	
								Grey Skate, ..	2	1	3	
								Angler, ...	..	2	2	
									36	111	147	
ame lity. eston age ring E. ¼ S. guard ion ¼ W. rding W.	Nov. 9.	6·6	9·5	10·2	9	9.50 a.m.	10.45 a.m.	Cod, ...	35	..	35	
								Haddock, ...	22	..	22	
								Plaice, ...	30	..	30	
								Lemon Dab, ..	1	..	1	
								Thornback, ..	2	3	5	
								Starry-ray, ..	..	19	19	
								Angler, ...	..	1	1	
									90	23	113	
lame lity. n off urgh to guard ion, N. to Collie- on.	Nov. 9.	..	..	..	6 to 9	10.45 p.m.	2.55 p.m.	Cod, ...	86	..	86	
								Codling, ...	..	1	1	
								Haddock, ...	158	1	159	
								Pollack, ...	28	..	28	
								Whiting, ...	1	34	35	
								Plaice, ...	86	2	88	
								Flounder, ...	..	1	1	
								Lemon Dab, ..	..	1	1	
								Com. Dab, ...	20	4	24	
								Starry-ray, ..	..	42	42	
								Grey Skate, ..	2	3	5	
									381	89	470	
ber- Bay. ack og f. W. Coast- ard tion, elvie, ¼ E. wled ¼ N.E. off elvie.	Dec. 17.	8·0	8·6	8·8	9 to 15	2.25 p.m.	3.55 p.m.	Codling, ...	..	2	2	"Star of Hope." S.W. moderate breeze. Heavy weather offshore.
								Haddock, ...	11	81	92	
								Whiting, ...	3	12	15	
								Plaice, ...	11	..	11	
								Com. Dab, ...	4	13	17	
								Long Rough Dab,	..	3	3	
								Grey Gurnard, ..	..	3	3	
								Herring, ...	..	5	5	
								Agonus, ...	..	1	1	
								Starry-ray, ..	..	1	1	
									29	121	150	

TRAWLING INVESTIGATIONS.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remar
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. Thrown Overboard.	Total No.	
2. Aberdeen Bay. Shot in 15 fms. off Belhelvie, trawled southward, lifted in 12 fms., with Girdleness light bearing S.W. by S.	1900. Dec. 17.	..	..	..	M'stly 6–7.	4.20 p.m.	7.20 p.m.	Cod, ...	1	..	1	
								Codling, ...	2	2	4	
								Haddock, ...	39	10	49	
								Whiting, ...	9	26	35	
								Plaice, ...	346	11	357	
								Com. Dab, ...	104	22	126	
								Dragonet, ...	..	1	1	
								Starry-ray, ..	13	50	63	
									514	122	636	
3. Same Locality. Shot where above lifted, half-way between Black Dog and Donmouth. Lifted in 9 fms., Girdleness bearing S.W. by S.	Dec. 17.	..	..	..	6 to 9	7.50 p.m.	10.30 p.m.	Cod, ...	1	..	1	Trawl got f bottom.
								Codling, ...	2	..	2	
								Haddock, ...	48	3	51	
								Whiting, ...	2	30	32	
								Plaice, ...	254	..	254	
								Com. Dab, ...	77	167	244	
								Grey Gurnard, ..	..	3	3	
								Starry-ray, ..	12	49	61	
									396	252	648	
4. Same Locality. Shot off Black Dog, Girdleness bearing S.W. Lifted off Donmouth.	Dec. 17 and 18.	..	..	..	9	10.55 p.m.	3 a.m.	Codling, ...	1	2	3	
								Haddock, ...	5	4	9	
								Whiting, ...	9	23	32	
								Turbot, ...	1	..	1	
								Halibut, ...	1	..	1	
								Plaice, ...	499	2	501	
								Lemon Dab, ..	..	1	1	
								Com. Dab, ...	166	28	194	
								Grey Gurnard, ..	..	2	2	
								Dragonet, ...	..	2	2	
								Starry-ray, ..	9	52	61	
								Angler, ...	..	1	1	
									691	117	808	
5. Same Locality. Shot where above lifted. Lifted off Belhelvie.	Dec. 18.	..	..	..	8 to 10.	3.25 a.m.	7.35 a.m.	Codling, ...	4	8	12	
								Haddock, ...	158	3	161	
								Whiting, ...	..	75	75	
								Plaice, ...	197	..	197	
								Com. Dab, ...	97	49	146	
								Grey Gurnard, ..	..	1	1	
								Herring, ..	1	..	1	
								Starry-ray,	13	125	138	
								Grey Skate,	1	..	1	
									476	257	733	
6, Same Locality. Shot in 8 fms. off Donmouth, Black Dog N. ½ E.; Gasworks, Aberdeen, W. ½ S.; Girdleness S. ½ W. Towed about N.E. Hauled in 8 fms. Black Dog W. ½ S., Girdleness S.S.W.	Dec. 18.	..	..	..	8	1.17 p.m.	2.47 p.m.	Whiting, ...	..	1	1	
								Plaice, ...	59	3	62	
								Com. Dab, ...	21	13	34	
								Grey Gurnard, ..	..	1	1	
								Dragonet, ...	..	1	1	
								Starry-ray, ...	..	4	4	
									80	23	103	

TRAWLING INVESTIGATIONS.

ace.	Date.	Temperature. Air.	Surface.	Bottom.	Depth in Fms.	Time Trawl Down. Shot.	Hauled.	Fish Caught. Name.	No. taken to Market.	No. Thrown Overboard.	Total No.	Remarks.
ıber- Bay. about e N.E. here st ıled. wled coast off eston.	1900. Dec. 18.	..	..	..	7–9	3.25 p.m.	7.25 p.m.	Cod, .. Codling, .. Haddock, .. Whiting, .. Plaice, .. Com. Dab, .. Grey Gurnard, .. Dragonet, .. Herring, .. Starry-ray, ...	1 2 21 .. 388 114 .. .. .. 48 574	.. 1 7 13 5 43 7 2 1 153 232	1 3 28 13 393 157 7 2 1 201 806	
ame ality. in 8½ Black W., leness W. urse out .E. ed in fms., osite ıelvie.	Dec. 19.	6·6	8·	8·4	6 to 8½	1.15 p.m.	2.45 p.m.	Whiting, .. Brill, .. Plaice, .. Com. Dab, .. Grey Gurnard, .. Starry-ray, ...	.. 1 148 26 .. 2 177	1 .. 3 9 5 7 25	1 1 151 35 5 9 202	
ame ality. where ıauled. wed herly fms. Black , and k in fms.	Dec. 19.	..	..	..	5 to 12	3.12 p.m.	6.25 p.m.	Brill, .. Haddock, .. Whiting, .. Plaice, .. Flounder, .. Com. Dab, .. Lemon Dab, .. Grey Gurnard, .. Dragonet, .. Starry-ray, ...	1 246 5 204 .. 86 .. .. .. 3 545	.. 163 115 3 4 23 1 4 2 12 327	1 409 120 207 4 109 1 4 2 15 872	
Same ality. New- rgh.	Dec. 19.	..	..	..	,,	7.15 p.m.	11.20 p.m.	Cod, .. Haddock, .. Whiting, .. Plaice, .. Com. Dab, .. Grey Gurnard, .. Starry Ray, ...	1 499 .. 242 126 .. 26 894	.. .. .. 3 36 1 61 ..	.. * * 245 162 1 87 ..	The unmarketable whitings and haddocks were not enumerated. Sea heavy; strong wind from S.S.W.
Same ality. t in 7 ns., leness V. by Black W. ½ lowed ıwards ıto llower ıter.	Dec. 21.	7·6	8·2	8·5	6 to 7	4·5 p.m.	5.35 p.m.	Cod, .. Haddock, .. Whiting, .. Plaice, .. Com. Dab, ...	11 2 .. 79 17 109	.. .. 1 .. 3 4	11 2 1 79 20 113	Heavy W. gale on 20th; moderated to-day, but strong W.N.W. breeze. Sea smooth near land.
Same ality. ıallow ter, 5 fms., coast, d down ween ieston o near k Dog.	Dec. 21.	..	..	..	5–7	6.30 p.m.	10.40 p.m.	Cod, .. Codling, .. Haddock, .. Whiting, .. Plaice, .. Com. Dab, .. Starry-ray, .. *Cottus scorpius*, ...	3 1 11 .. 54 15 4 .. 88	.. .. .. 40 .. 7 14 1 62	3 1 11 40 54 22 18 1 150	About 1 basket of swimming crabs.

TRAWLING INVESTIGATIONS.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remark
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. Thrown Overboard.	Total No.	
13. Aberdeen Bay. Belhelvie to Newburgh and back.	1900. Dec. 21 and 22.	..	..	..	10	11.15 p.m.	3.10 a.m.	Cod,	11	..	11	
								Codling,	2	..	2	
								Haddock,	41	7	48	
								Whiting,	1	32	33	
								Plaice,	95	..	95	
								Lemon Dab,	1	..	1	
								Com. Dab,	21	13	34	
								Sail-fluke,	2	..	2	
								Starry-ray,	9	17	26	
									183	69	252	
1. Moray Firth. Off Golspie, Dornoch Firth.	Dec. 24.	..	8·0	8·2	10	3.15 p.m.	5.15 p.m.	Cod,	..	..	4	"Star of I The mark and unm able were separately merated i series.
								Codling,	..	..	32	
								Haddock,	..	..	39	
								Whiting,	..	..	9	
								Plaice,	..	..	231	
								Lemon Dab,	..	..	4	
								Com. Dab,	..	..	43	
								Long Rough Dab,	..	..	13	
								Witch,	..	..	1	
								Skate,	..	..	2	
								Angler,	..	..	1	
									..	..	379	
2. Same Locality.	Dec. 24.	..	..	..	9–10	5.35 p.m.	9.35 p.m.	Cod,	..	..	6	
								Codling,	..	..	2	
								Haddock,	..	..	35	
								Whiting,	..	..	6	
								Brill,	..	..	1	
								Plaice,	..	..	146	
								Com. Dab,	..	..	19	
								Sail-fluke,	..	..	1	
								Long Rough Dab,	..	..	9	
								Skate,	..	..	21	
								Angler,	..	..	1	
									..	..	247	
3. Same.	Dec. 24 and 25.	..	..	..	10	10 p.m.	2.10 a.m.	Cod,	..	..	4	
								Codling,	..	..	4	
								Haddock,	..	..	39	
								Brill,	..	..	7	
								Plaice,	..	..	268	
								Com. Dab,	..	..	32	
								Witch,	..	..	1	
								Grey Gurnard,	..	..	1	
								Skate,	..	..	7	
									..	..	363	
4. Same.	Dec. 25.	..	..	..	10	2.35 a.m.	3.45 a.m.	Cod,	..	..	15	
								Codling,	..	..	45	
								Ling,	..	..	1	
								Haddock,	..	..	226	
								Whiting,	..	..	10	
								Plaice,	..	..	117	
								Lemon-Dab,	..	..	8	
								Com. Dab,	..	..	16	
								Skate,	..	..	10	
									..	..	448	

TRAWLING INVESTIGATIONS.

ace.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. Thrown Overboard.	Total No.	
ame. Dunobin astle.	1900. Dec. 25.	..	..	..	12	4.55 a.m.	9.30 a.m.	Codling, ...	..	..	25	Cod end got split on bottom.
								Haddock, ...	..	..	24	
								Whiting, ...	..	..	6	
								Plaice, ...	..	..	95	
								Lemon Dab, ..	..	..	2	
								Com. Dab, ...	..	..	60	
								Long Rough Dab,	..	..	4	
								Cat-fish, ...	..	..	1	
									..	..	217	
Same. Dunobin astle.	Dec. 25.	..	..	..	12	10.10 a.m.	11.40 a.m.	Codling, ...	..	..	2	The herrings were all under 6 inches.
								Haddock, ...	..	..	8	
								Whiting, ...	..	..	5	
								Brill, ...	..	..	1	
								Plaice, ...	..	..	182	
								Lemon Dab, ..	..	..	1	
								Com. Dab, ...	..	..	2	
								Herring, ...	..	..	8	
									..	..	209	
Same.	Dec. 25.	..	..	..	12	12.40 p.m.	3.40 p.m.	Cod, ...	..	..	9	
								Codling, ...	..	..	48	
								Haddock, ...	..	..	31	
								Whiting, ...	..	..	42	
								Turbot, ...	..	..	1	
								Brill, ...	..	..	1	
								Plaice, ...	..	..	316	
								Com. Dab, ...	..	..	30	
								Skate, ...	..	..	1	
									..	..	479	
Same. Dunobin astle.	Dec. 25.	..	8·0	8·1	10	4 p.m.	8.10 p.m.	Cod, ...	..	..	2	
								Codling, ...	..	..	19	
								Haddock, ...	..	..	103	
								Whiting, ...	..	..	43	
								Brill, ...	..	..	2	
								Plaice, ...	..	..	550	
								Lemon Dab, ..	..	..	6	
								Com. Dab	..	..	143	
								Witch, ...	..	..	1	
								Cat-fish, ...	..	..	1	
								Skate, ...	..	..	3	
									..	..	873	
Same.	Dec. 25 and 26.	..	..	..	10 to 12	8.35 p.m.	1 a.m.	Cod, ...	..	..	10	
								Codling, ...	..	..	19	
								Haddock, ...	..	..	118	
								Whiting, ...	..	..	53	
								Brill, ...	..	..	4	
								Plaice, ...	..	..	614	
								Lemon Dab, ..	..	..	4	
								Com. Dab, ...	..	..	87	
								Witch, ...	..	..	4	
								Long Rough Dab,	..	..	11	
								Skate, ...	..	..	2	
								Angler, ...	..	..	1	
									..	..	927	

TRAWLING INVESTIGATIONS.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarl
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. Thrown Over-board.	Total No.	
	1900.											
10. Same.	Dec. 26.	..	..	..	10 to 12	1.20 a.m	5.30 a.m.	Cod, ...	..	..	14	
								Codling, ...	..	..	8	
								Haddock, ...	..	..	137	
								Whiting, ...	..	..	89	
								Brill, ...	..	..	4	
								Plaice, ...	..	..	559	
								Lemon Dab, ..	..	..	6	
								Com. Dab, ...	..	..	134	
								Witch, ...	..	..	1	
								Cat-fish, ...	..	..	1	
								Grey Gurnard, ..	..	..	2	
								Skate, ...	..	..	4	
									..	..	959	
11. Same.	Dec. 26.	..	..	..	12	6 a.m.	10 a.m.	Cod, ...	..	..	4	
								Codling, ...	..	..	27	
								Haddock, ...	..	..	112	
								Whiting, ...	..	..	12	
								Brill, ...	..	..	2	
								Plaice, ...	..	..	456	
								Lemon Dab, ..	..	..	5	
								Com. Dab, ..	..	..	124	
								Long Rough Dab,	..	..	11	
								Sail-fluke, ...	..	..	1	
								Grey Gurnard, ..	..	..	2	
								Cat-fish, ...	..	..	1	
								Skate, ...	..	..	8	
									..	..	765	
12. Same.	Dec. 26.	..	8·0	8·2	12	10.30 a.m.	2.45 p.m.	Cod, ...	..	..	5	
								Codling, ...	..	..	31	
								Haddock, ...	..	..	54	
								Whiting, ...	..	..	28	
								Brill, ...	..	..	3	
								Plaice, ...	..	..	649	
								Lemon Dab, ..	..	..	2	
								Com. Dab, ..	..	..	57	
								Long Rough Dab,	..	..	4	
								Grey Gurnard, ..	..	..	2	
								Cat-fish, ...	..	..	2	
								Skate, ...	..	..	2	
									..	..	839	
13. Same.	Dec. 26.	..	..	..	12	3.5 p.m.	7.20 p.m.	Cod, ...	..	..	22	
								Codling, ...	..	..	51	
								Haddock, ...	..	..	210	
								Whiting, ...	..	..	60	
								Black Sole, ..	..	..	..	
								Plaice, ...	..	..	549	
								Lemon Dab, ..	..	..	46	
								Com. Dab, ..	..	..	87	
								Sail-fluke, ...	..	..	1	
								Long Rough Dab,	..	..	6	
								Cat-fish, ...	..	..	4	
								Skate, ...	..	..	6	
								Angler, ...	..	..	1	
									..	..	1043	
14. Same.	Dec. 26.	..	..	..	12	8 p.m.	10 p.m	Cod, ...	..	..	2	Net split on g
								Codling, ...	..	..	6	
								Haddock, ...	..	..	61	
								Whiting, ...	..	..	12	
								Brill, ...	..	..	1	
								Plaice, ...	..	..	232	
								Lemon, ...	..	..	2	
								Com. Dab, ...	..	..	14	
								Grey Gurnard, ..	..	..	1	
								Angler, ...	..	..	1	
									..	..	332	

TRAWLING INVESTIGATIONS.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. Thrown Over-board.	Total No.	
Same.	1900. Dec. 26 and 27	..	..	..	12	10.30 p.m.	1.45 a.m.	Cod, ...	..	..	2	Net very badly split on bottom.
								Codling, ...	..	..	1	
								Haddock, ...	..	..	1	
								Plaice, ...	..	..	38	
								Com. Dab, ...	..	..	25	
								Long Rough Dab,	..	..	2	
								Skate, ...	..	..	2	
									..	..	71	
Same.	Dec. 27.	..	..	..	12	2.10 a.m.	6.25 a.m.	Cod, ...	..	..	4	
								Codling, ...	..	..	25	
								Haddock, ...	..	..	49	
								Whiting, ...	..	..	96	
								Brill, ...	..	..	1	
								Plaice, ...	..	..	429	
								Lemon Dab, ..	..	..	3	
								Com. Dab, ...	..	..	143	
								Flounder, ...	..	..	1	
								Long Rough Dab,	..	..	15	
								Grey Gurnard, ..	..	..	6	
								Skate, ...	..	..	2	
									..	..	774	
Same.	Dec. 27.	..	5·6	8·0	12	7 a.m.	11.10 .m.	Cod, ...	..	..	6	
								Codling, ...	..	..	9	
								Haddock, ...	..	..	27	
								Whiting, ...	..	..	18	
								Brill, ...	..	..	1	
								Plaice, ...	..	..	379	
								Lemon Dab, ..	..	..	2	
								Com. Dab, ...	..	..	81	
								Flounder, ...	..	..	2	
								Long Rough Dab,	..	..	8	
								Cat-fish, ...	..	..	1	
								Grey Gurnard, ..	..	..	7	
								Skate, ...	..	..	1	
								Angler, ...	..	..	1	
									..	..	543	
Same.	Dec. 27.	..	..	..	12	11.50 a.m.	3.50 a.m.	Cod, ...	..	..	10	
								Codling, ...	..	..	13	
								Haddock, ...	..	..	48	
								Whiting, ...	..	..	19	
								Halibut, ...	..	..	1	
								Brill, ...	..	..	4	
								Plaice, ...	..	..	434	
								Com. Dab, ...	..	..	37	
								Flounder, ...	..	..	4	
								Long Rough Dab,	..	..	9	
								Cat-fish, ...	..	..	2	
								Grey Gurnard, ..	..	..	4	
								Skate, ...	..	..	2	
								Angler, ...	..	..	1	
									..	..	588	

III.—ON THE LARVAL STAGES OF DECAPOD CRUSTACEA—THE SHRIMP (*CRANGON VULGARIS, FABR.*).

By H. Chas. Williamson, M.A., B.Sc., Marine Laboratory, Bay of Nigg, Aberdeen. (Plates I.–VI.)

CONTENTS.

	PAGE.
Introduction,	92
The Movements of the Larva,	93
The Moulting of the Larva,	94
The Larval Stages,	94
Development of the Appendages :—	96
Antennule	96
Antenna,	97
Mandible,	100
First Maxilla,	100
Second Maxilla,	101
First Maxillipede,	102
Second Maxillipede,	103
Third Maxillipede,	104
Telson,	106
Pereiopods,	108
Pleopods,	112
The Eyes,	113
The Branchiæ,	113
The Zoëa,	114
Literature,	115
Explanation of Plates,	116

INTRODUCTION.

The larval stages of the Shrimp have been more or less fully described by Du Cane, Claus, Sars, and Ehrenbaum. Du Cane* figured the first stage; Sars† describes minutely the first and last larval stages; Ehrenbaum‡ gives a detailed description of the five larval stages, the first young stage (VI.), and of the prelarval stage, which is the homologue of the protozoëa of the Brachyura. The last author arranged all the shrimp larvæ captured by means of the tow-net into a series of five stages. He admits (*p. 64*) that this method of forming the series does not preclude the possibility of there being a greater number of moults than five in the larval period.

The method which I have followed is that of forming a series, the different stages of which are all connected by moults, and my results confirm the arrangement of Ehrenbaum. The larvæ which hatched at the Laboratory developed to the third stage. For the most of my material I was indebted to tow-net collections. Some of these were made by the "Garland," and it is noteworthy of the hardiness of the zoëæ of the shrimp, and also of certain Brachyura, that, even after a railway journey of eight hours in glass jars, a considerable number of those despatched by Mr. Pearcey from the Moray Firth not only survived but moulted in the Laboratory.

The larvæ obtained then by means of the tow-net were, as Ehrenbaum found, in five stages, and that these are the only stages in the larval

* Du Cane, "Metamorphosis of Crustacea." *Annals of Natural History*, Vol. 2, 1839.

† Sars, "Bidrag til Kundskaben om Decapodernes Forvandlinger," III., Crangonidæ. *Archiv f. Mathem. og Naturv.* Christiania, 1890. [For the translation of Sars' paper I am indebted to the courtesy of Mr. H. C. Dannevig.]

‡ Ehrenbaum, "Zur Naturgeschichte von *Crangon vulgaris*." Berlin, 1890.

period was proved by the fact that the form resulting from the moult of each stage was identical with one of the stages captured in the sea. The individuals of each stage were separated from the other stages, and kept until they moulted or died. In the latter case new supplies were obtained, until all the stages had moulted. The larvæ of the fifth stage cast readily in confinement into stage VI., and there was no difficulty in obtaining in this way a considerable number of forms of the latter stage. These were reared to the ninth stage, *i.e.* through four successive moults. In the case of the larvæ no food was supplied other than was contained in the water supply. A little liver of the crab was added occasionally to the jars in which the sixth and later stages were kept, but in these cases also the young forms probably received their nourishment from the water, which was kept circulating. A running supply of water was not found necessary in all cases for the well-being of the larvæ. Occasionally the water of the jars containing a few individuals was changed only once a day, but for this no fixed rule can be made. It is necessary to find out by experiment how often the water requires to be changed, or if a constant circulation is needed.

The external eggs of the Shrimp when a short time extruded have to the naked eye a whitish appearance, with a very slight pink tinge. They are oval in shape, and do not vary much in size. The measurements in millimetres of six eggs were as follows:—·45 × ·35; ·4 × ·37; ·45 × ·4; ·47 × ·37; ·4 × ·4; ·4 × ·4. As development of the embryo proceeds, the eggs gradually become translucent, and the pink tinge disappears. Immediately before hatching, the eggs are much larger than in the early embryonic stages. Four eggs containing fully developed embryos measured ·65 × ·47; ·85 × ·6; ·8 × ·6; ·45 × ·6.

I propose in the following pages to trace the development of each of the appendages of the shrimp through the first seven stages.

The first larval stage (fig. 152), descriptions of which are given by Sars and Ehrenbaum, is small, transparent, and flecked with luminous yellow pigment. The pigment is distributed on the eye, side of carapace, bases of the appendages, the hind dorsal and ventral regions of the abdominal segments, and on the telson. Associated with each of the patches of yellow there is some brown pigment. The yellow pigment throughout is luminous, and by reflected light glistens with silver sheen.

The larva is not straight, but is bent in a slight curve; it possesses nine pairs of appendages in addition to the telson—viz., (1) the eyes, (2) antennules, (3) antennæ, (4) mandibles, (5 and 6) two pairs of maxillæ, (7, 8, and 9) three pairs of maxillipedes.

The Movements of the Larva.

The movements of the larva are remarkable, as was noted by Du Cane, and later by Sars, Ehrenbaum, and Weldon;* they partake of a gyrating motion. The larva rotates on its own axis, and is simultaneously travelling in a spiral. Occasionally it lies on its back and swims in that position head first. The setose exopodites of the second and third maxillipedes are the main swimming organs; the part played by the exopodite of the first maxillipede appears to be secondary. The sudden jerks which the larva sometimes gives are made by means of the telson. The rotating motion Weldon considers to be due to the absence of the long rostral and dorsal spines which are found in Brachyurous Zoëæ.

* Weldon, "The Function of the Spines of the Crustacean Zoëa." *Journal Marine Biological Association.* N.S., Vol. I., p. 169.

The Moulting of the Larva.

When the larva casts, the carapace is raised up from the thorax and the abdomen is bent forward close up along the ventrum of the cephalothorax. In this position the abdomen is drawn out of its integument. The newly released abdomen is similarly pushed forward under the cephalothorax, and the spines of the telson entangle themselves in the cephalic or thoracic appendages. The abdomen is then drawn to its normal position and the process repeated. This movement goes on until the integuments of the appendages are pushed off. The telson in the larval stages is not a swimming organ; it functions mainly in enabling the larva to get rid of its integument when it moults. The serrated spines with which the hind border of the telson is armed (figs. 4, 13, 7, 1, 3, etc.) materially aid its action. The cast integument is usually in one piece, the sternum of the thorax remaining attached to the sternum of the first abdominal segment. Occasionally, however, the cast is in two parts, one of which is the abdomen, and the other the remainder of the moulted skin (*cf.* Ehrenbaum, *pp.* 74 and 75).

The Larval Stages (Plates V., Figs. 152, 157, 158, 167, and VI., Fig. 170).

The recognition of the larval stages of the shrimp is comparatively easy. All the stages have the characteristic colouring, though varying somewhat in intensity, and the following structures of the first stage—viz., (*a*) the sharp slender keeled rostrum; (*b*) the three teeth on the anterior part of the lateral border of the carapace; (*c*) the stout posteriorly directed spine on the hind border of the third abdominal segment; (*d*) the two long lateral tooth-like projections of the hind border of the fifth abdominal segment.

It will not be necessary to give here more than a few characters by which the different stages may be separated, since the development of each appendage is treated below in detail (p. 96 *et seq.*). The different stages differ in size, but the larvæ of the same stage also vary considerably in size.

In the first four stages the telson is triangular in shape (Plate I.), that is, its hind margin is much greater than its base (*i.e.*, its line of attachment to the sixth abdominal segment). In the fifth stage the hind margin is very little greater than its base, and the telson is almost rectangular in shape (fig. 3).

The first and second stages differ from the remaining three in that in the former the uropods have not appeared externally, whereas they are present in the latter.

The first stage, fig. 4 (length 1·84–1·22 mm., Ehrenbaum) is readily distinguished from the second by the fact that there are 14 serrated spines on the hind margin of the telson, while in the second (length 2·82 mm., Ehrenbaum) (fig. 13) and remaining stages there are 16 spines.

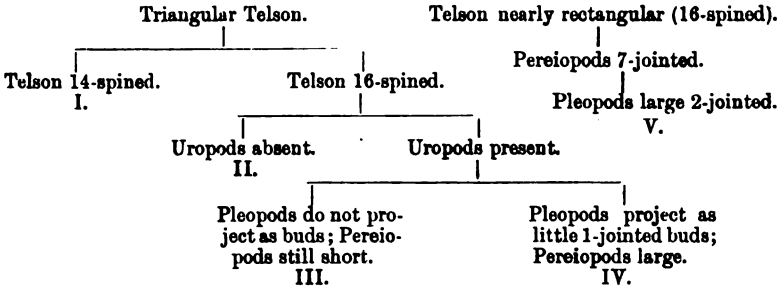
In stage III., figs. 7 and 167 (length 3·4 mm., Ehrenbaum), the uropods are present for the first time, and are small. The pleopods do not project as buds; they may be traced inside the swellings on the ventral surface of the abdominal segments. The pereiopods are small, and with the exception of the first, which consists of a single-jointed protopodite and single-jointed exopodite and endopodite, are unsegmented, fig. 137, *a* and *b*. The exopodite of the first bears six swimming setæ.

Stage IV., fig. 170 (length 3·84 mm., Ehrenbaum). The pleopods project as short bud-like processes below the pleura. The pereiopods are

large; the endopodite of the first has four segments (fig. 147); the third, fourth, and fifth pereiopods have two joints (fig. 145).

Stage V., fig. 158 (length 4·5–4·7 mm., Ehrenbaum). The pereiopods are all seven-jointed (fig. 149). The pleopods are long spatulate, two-jointed processes (fig. 176).

The differences between the larvæ are represented roughly in the following scheme:—



Stage VI., fig. 160, 4·25–4·3 mm. in length (Ehrenbaum). In this stage the young shrimp has assumed the characters of the adult. All the appendages are present and functional; they are not, however, fully developed. The flagellum of the antenna has only 17 to 21 joints. The young form is now almost straight, in place of being bent as the larva is. This stage, which corresponds generally to the megalops stage of the Brachyura, is not with strict accuracy called the first young stage. The carapace now ends in a short blunt rostrum (fig. 199); it has a keel, on either side of which there is a pair of short hairs (fig. 188). At the outer edge of the orbit the carapace is prolonged into a strong spine; the inferior border of the carapace ends anteriorly in a similar structure, close behind which there is a little tooth. The lateral edge of the carapace is furnished with a series of plumose hairs (fig. 199); and its distal portion is provided with five densely plumose setæ. They all arise from the internal surface of the carapace. Three plumose hairs are situated on the edge of the orbit, and over the dorsal surface of the rostrum and that of the carapace little hairs are scattered. A prominent spine is present in the middle line some little distance behind the base of the rostrum. In this stage the lateral dorsal spine (l.s.p., fig. 190), which is present in stage VII., is absent, though in certain individuals a little blunt process was observed in that region. The sternal spine, which is a process of the sixth thoracic segment (that bearing the third pereiopod), is prominent (s.p., figs. 187 and 192). On the sternum of the last two thoracic segments there are four plain hairs.

The abdominal segments are furnished with short hairs on their dorsal regions, and with long plain hairs on the internal edge of the pleura. On the anterior edge of the tergum of the first segment there is a fringe of plumose hairs, which overlap the dorsal intermediary piece x which fills the space between the posterior edge of the carapace and the anterior edge of the first abdominal segment, (figs 156 and 160). The pleuron of the second segment overlaps the first and third segments. The anterior edge of the tergum of each segment is overlapped by the segment in front of it. The posterior border of the tergum is minutely notched. In the middle line of the sternum of each of the first five segments there is a rounded knob surmounted by a hair (fig. 192).

Stage VII., (fig. 180), about 6mm. in length. The shrimp of this stage is much larger than that of stage VI., and there are also a number of

structural differences. The lateral dorsal spine of the carapace, *l. sp.* (figs. 180, 189, and 190), has appeared. There is also a number of small teeth on the dorsal surface, near the base of the median spine, and at other points. There are two plumose hairs on the keel of the rostrum. The last two thoracic segments are adorned symmetrically on each side of their ventral surfaces with a number of plumose hairs (fig. 194). Certain of these are located on the edge of slit-like openings in the joints between the last three segments. Across the middle of the last three thoracic segments there is a faintly-marked broad stripe that is continued anteriorly into the sternal spine. The only difference noted in the abdomen is an increase in the number of minute hairs scattered over the dorsal surface of the same (fig. 156). The knobs on the sternal regions of the first five abdominal segments are surmounted by two hairs (figs. 154 and 163); the fifth showed one only in the preparation examined (fig. 155).

Stage VIII. measured about 7·5 mm.; stage IX. about 10·5 mm. in length.

Development of the Appendages.

The development of each appendage will be traced through the larval stages and the first two young stages. They will be taken in the following order:—Antennule, p. 96; Antenna, p. 97; Mandible, p. 100; first Maxilla, p. 100; second Maxilla, p. 101; first Maxillipede, p. 102; second Maxillipede, p. 103; third Maxillipede, p. 104; Telson, p. 106; Pereiopods, p. 108; Pleopods, p. 112; Eyes, p. 113; Branchiæ, p. 113.

Antennule. (Pl. II.).

I. The antennule in this stage (fig. 59) consists of a long basal joint bearing at its distal extremity two branches, the inner of which is a long stout seta, plumose for the most of its length, and provided at its tip with a few teeth set in two rows. The outer branch, exopodite, is a cylindrical basal portion bearing three sensory tube-like processes and a long hair. These processes are in connection with the large ganglion (*g*) situated in the basal joint.

II. The character of this appendage has changed considerably (fig. 56): the basal portion is now two-jointed, and of the two the proximal is the longer joint. The exopodite and endopodite are now separated from the basal portion by septa, that of the endopodite being only indistinctly marked; it remains indistinct until the sixth stage. The exopodite resembles that of stage I., but the endopodite consists of a strong tapering process ending in a broad tooth-like termination. From the base of this tooth arise two teeth, one short and stout, the other longer and slender. Arising from the top of the second basal joint there is a long plumose seta, equalling in length the endopodite, and between the exopodite and endopodite there is on the top of the second joint a group of plumose setæ. On the anterior edge of the first basal joint there are four feathered setæ, and a fifth arises a short distance back from the edge.

III. A condition similar to the preceding stage is found, except that a hair has appeared on the exopodite close to the base of the sensory processes (fig. 62).

IV. In this stage the basal joint shows a little further development (fig. 60). A slight notch on the outer side of the first basal joint, which was traceable in stage III., is now very evident. This indicates the origin of the plate-like expansion which is fully developed in stage VI. Four sensory processes are now present on the exopodite.

V. The number of sensory processes has been increased to six, by the addition of two short ones which arise on the ventral surface of the

exopodite, some little way behind the bases of the original processes (figs. 45 and 44). A group of plumose setæ on the outer edge of the first basal joint indicates the position of a septum in the following stage. The tip of the endopodite is furnished with three teeth in addition to its tooth-like termination (fig. 65). The rudiment of the basal plate has increased in size (fig. 45).

VI. The antennule has changed very materially (fig. 63). There are now three basal joints; the proximal is the longest, and bears on its outer side a large plate roughly rhomboidal in shape and terminating anteriorly in a sharp angle. Along the outer edge of the latter and on its dorsal surface there is a row of 10 plumose setæ. The first basal joint encloses the auditory organ, which opens on the dorsal surface by an aperture fringed along one side with plumose hairs, 9 *ca.** Inside the cavity of the ear there is on a ridge a row of 7 *ca.* delicate-walled setæ. These appeared to be plumose, but the feathering was not satisfactorily made out. On the ventral surface of the joint there is a large strong tooth (*t*). A group of 8 plumose hairs on the outer side of this joint, in the angle between it and the plate, is prominent. The fringe of hairs round one side of the opening of the auditory sac is continued anteriorly to the distal edge of the joint by another row of 7 setae which begins where the former leaves off. The second row begins with a small seta, and the succeeding hairs increase in size as they recede from the first. The anterior edge of the first joint is furnished with a number (14*ca.*) of setæ which with one exception are plumose. They are concentrated on the outer side, two only being on the inner edge. On the second joint there is a similar arrangement; of the 10 setæ on the anterior edge, 8 are on the outer edge, one median (in the sketch), and one on the inner edge. On the dorsal surface at the base of the exopodite there is a group of 4 hairs, while between the exopodite and endopodite there is the group of plumose hairs which was present in the larval stages. On the third basal joint at the base of the endopodite there are two setæ. The endopodite is now two-jointed and bears at its tip a group of hairs, of which four at least are plumose. On the distal edge of the first joint of this branch there are four hairs. The exopodite consists of three joints, the most distal of which bears four sensory processes, while the upper edge of the second joint gives origin to two other processes which are shorter and more slender than the others. There are two short hairs at the base of the larger processes, and three hairs on the edge of the second joint. The large ganglion connected with the sensory processes is contained in the second and third basal joints (*g*).

VII. (fig. 54). Accompanying an increase in size in the appendage there is in this stage an addition to the number of joints in the endopodite. It now consists of three joints, with the septum of a fourth indicated. The exopodite remains three-jointed, the distal bearing four sensory processes, while the second joint now bears three processes, of which one, short and slender, appears for the first time. The number of setæ all over has increased. Thus on the anterior edge of the first joint there are 15, of the second joint 12, and there is a corresponding increase on the exopodite and endopodite, as is shewn in the figure. On the *dorsal* surface of the second basal joint a small tooth has appeared, and associated with it there is a short hair (*t*).

Antenna A. (Pl. II.).

I. (fig. 51). The antenna of this stage consists of a single basal joint bearing an exopodite and an endopodite. The exopodite is a flattened

* For a detailed description of the ear in the Shrimp and other Decapod Crustacea, *cide* Hensen, "Studien über das Gehörorgan der Decapoden." *Zeitschr. f. Wissenschaft. Zoologie*, Bd. 13, p. 319; 1863.

scale bearing a fringe of plumose setæ. On the anterior extremity there is a group of four hairs, one a short plain hair, the others plumose. Of the latter the outer is the shortest, the second is larger than the first, and the third than the second. The inner anterior margin bears five long plumose setæ. Behind the terminal group and on the outer edge where it turns outwards there is a feathered hair (*s*), and further posteriorly there is a short plain hair.

The endopodite consists of a thick cylindrical basal part which tapers into a stout bristle-like distal portion, which is furnished with two rows of teeth. It reaches in length to the level of the anterior edge of the scale. Its serrated portion is longer than the swollen basal portion. At the base of the endopodite the anterior edge of the basal joint is produced into a strong tooth. The endopodite lies on the ventral side of the exopodite.

II. (fig. 58). In passing from the preceding into the second stage both the exopodite and endopodite undergo change.

A large terminal tooth has developed on the distal end of the outer edge of the scale. It develops in the rounded projecting part which bears the short plumose hair, *s* fig. 51. In fig. 47 b, which shows the scale of a larva preparing to cast, the spine can be seen folded upon itself, *sp*. It is shown unfolded and fully extended in fig. 47 a, a drawing from a larva which has begun to moult. All the terminal hairs present in the first stage are reproduced in the second, fig. 47, and the tooth does not arise in place of a hair as Sars suggests.

In stage II. there are five terminal hairs; of these the two next the spine are very small. One of these arises from the base of the tooth and is the isolated plumose hair of the first stage. There is an extra plumose seta on the inner side of the scale, which makes the total number 11.

In the endopodite the proximal cylindrical portion has increased in size, while the terminal serrated part has shortened. During the succeeding larval stages this process goes on steadily; the cylindrical portion gradually absorbs the serrated part, until, in the last larval stage, the latter is reduced to a vanishing point.

III. There are five terminal hairs, three of which are plumose; the remaining two are short and plain. On the inner edge the setæ are seven in number, an increase of one on stage II. The scale has thus a total of 12 hairs.

The serrated portion of the endopodite is further reduced; it is now only about one-fourth of the total length of the branch. The two (or three) proximal teeth are much longer than the others.

The protopodite is now two-jointed.

IV. (fig. 64). Of the five terminal hairs of the scale there are four feathered; and there are now nine setæ on the inner edge—a total of 14.

The endopodite now shows the beginning of a separation into two joints. The serrated portion is still further reduced, and bears a few teeth arranged in two rows (fig. 61).

V. (fig. 50). The five terminal hairs of the scale are now all feathered. There are 12 lateral setæ, giving 17 setæ to the scale.

The endopodite is now two-jointed. All that remains of the serrated portion is the spinous tip, accompanied by three slender curved hairs (fig. 48).

VI. (fig. 52). The changes which take place in this stage are considerable and important. The antennal scale has an increased number of setæ, viz., 18 in all; the terminal group of five is still sharply separated from the rest. On the outer edge of the scale there are several short plain hairs. These are mainly on the dorsal surface.

The character of the endopodite has completely changed. It now consists of a two-jointed base and a flagellum. The former corresponds to the first joint and the latter to the second joint of the endopodite of stage V. Of the basal portion the first joint (1b) is small; the second (2b) is long and broad. Both are provided with setæ. On the inner side of the distal edge of the second joint there is a characteristic group of two short feathered setæ and two long plain hairs. The number of joints in the flagellum varies in different individuals, and may vary in the two antennæ of the one specimen; they usually number 17 or 20 (21). Fig. 52 shows an antennal whip of 17 joints. Fig. 46 is a drawing of one having 20 joints. The first joint is small, and without hairs; the second is long, slightly tapering, and bears at its distal end a group of hairs. In the case of the 17-jointed whip the group consists of four hairs, two of which are on the anterior edge, and one each on the dorsal and ventral surfaces. At a little distance short of the end of the joint there is a pair of hairs on the anterior susface. In the 20-jointed whip, the second joint bears only three hairs, two of which are anterior, and the third dorsal. The flagellum tapers gradually. The tip of the last joint is furnished with six hairs, four of which are on the anterior surface, while the remaining two are on the dorsal and ventral surfaces respectively (fig. 57). The last joint but one has only two hairs, and these are anterior. In the flagellum, then, there is a double series of joints, in one of which each joint bears six terminal hairs, while in the other each joint bears two hairs. These joints are arranged alternately in the greater part of the whip; this arrangement is not, however, followed in its proximal part. One or two joints are not provided with hairs, *e.g.*, the third joint in the 17-jointed flagellum, and the 3rd and 7th in the 20-jointed example. In the latter the 5th joint has two anterior hairs, and one each dorsal and ventral. The hairs are not all alike: in each group of four or two, on the anterior surface, one of the hairs is usually of a structure similar to the sensory hairs present on the first antenna of a Copepod. It does not taper to a point as an ordinary hair, but remains of one breadth throughout its length (ae. fig. 57). These sensory hairs have been called æsthetascs by Giesbrecht.*

On the 17-jointed whip the numbers of hairs on the different joints were as follows:—1st joint, 0; 2nd, 2 at about a fourth of its length from the end, and 2+2 at its distal edge; 3rd, 0; 4th, 4+2; 5th, 4+2; 6th, 2; 7th 4+2; and so on alternately, 2 and 4+2. The 20-jointed whip had the following arrangement of hairs:—1st joint, 0; 2nd, 2+1; 3rd, 0; 4th, 4+2; 5th, 2+2; 6th, 4+2; 7th, 0; 8th, 4+2; 9th, 2; 10th, 4+2; and so on 2 and 4+2, alternately.

The coxopodite has a round disc-like projection on its inner side.

VII. (figs. 49 and 53). The basipodite bears five long plumose setæ.

The antennal scale has 25 setæ. On the outer edge there is a row of teeth and small hairs.

The flagellum in the specimen of this stage had 28 joints. The drawing represents the right antenna. In the left antenna the little hair on the dorsal surface of the second joint was absent, while there was an extra hair at the depression on the anterior surface; and at the distal end of the same joint there were four anterior hairs. The general alternating of the two series of joints noticed in the preceding stage is present here also. The number of hairs on the joints of the flagellum were as follows:—1st joint, 0; 2nd (about the middle, 2+1; at distal end, 3+2); 3rd, 1; 4th, 4+2; 5th, 2+2; 6th, 4+2; 7th, 2; 8th, 4+2; 9th, 2; 10th, 4+2; 11th, 2; 12th, 4+2; and so on alternately, 2 and 4+2.

* Giesbrecht, "Pelagischen Copepoden des Golfes von Neapel." Berlin, 1892.

Mandible (mn., Plate II.).

I. The mandible in the first stage (fig. 40) has an outer cutting and an inner gnawing portion. In the cutting portion the teeth are provided with a few serrations. One large curved tooth is serrated along one side. On the inner side of the chewing portion of the mandible there is a fascicle of 4 or 5 stiff bristles present in this stage only.

II.–V., figs. 33, 38, 39, 41. The general character of the mandible remains the same during the larval stages, except that the intermediate teeth show long, sharp, and irregularly disposed serrations. As Sars pointed out, the two mandibles are not always exactly similar, *cf.* fig. 41.

VI., fig. 37. In this stage the mandible has four rounded processes furnished at their bases with little teeth.

VII., fig. 34. The teeth have increased in number, although the general arrangement is the same as in the preceding stage.

First Maxilla (1 m., Plate III)

I. (fig. 68). The first maxilla is composed of two main parts. The upper is the palp (endopodite); the bilobed lower portion (protopodite) is the chewing organ (Sars). The palp bears five bristles, which are furnished with a few long teeth. The tips of certain of the bristles would appear to be minutely serrated, but this was not always made out in this stage.

The upper masticatory lobe bears three dentate blades, and above and below these there is a deeply serrated spine; the lower lobe is furnished with five deeply serrated spines. On the upper edge of the latter lobe there is a short stout hair bearing a few cilia (fig. 79). On the lower edge of the upper lobe there is a small group of cilia.

II.–V. (figs. 76, 75, 77, 74). A little hair is added at the base of the inferior bristle of the palp in stage II. The three long bristles are in stage III. serrated on both sides at their tips; and in stage V. the two short bristles are similarly adorned.

The number of dentate blades on the upper masticatory lobe is increased to 5, and they are accompanied by three deeply serrated spines.

In the lower lobe the general arrangement of the spines appears to be that shown more definitely in fig. 74 (stage V.). On the upper edge there is the bristle mentioned as present in stage I., and a plain hair; next come two deeply serrated spines, followed by three bristles serrated on both sides. At the inferior corner there is a plain hair.

In stages III. and IV. (figs. 75 and 77) the cilia on the lower side of the upper lobe were noticed (*c*).

VI. (fig. 82). While the general structure of the first maxilla remains unaltered, the armature has undergone some change. Thus the palp has now only a simple spike-like bristle situated on its inner edge.

The upper masticatory lobe is furnished with six serrated blades and three bristles.

The inferior lobe is provided with three plain spines.

VII. (fig. 69). In this stage the armature has further developed.

The palp now possesses, in addition to the spike, a plumose seta which is attached to the posterior surface.

The upper masticatory lobe has, in addition to the six dentate blades, a number of serrated bristles. These are for the most part serrated on one side only. Certain of them are, however, ciliated on the other side. The newly developed bristles are situated on the upper edge principally.

The lower lobe has now four plain spines.

SECOND MAXILLA (2 m., Plate III.).

I. (fig. 80). Sars gives the following description of the second maxilla of the first stage. "The second pair of maxillæ is more complicated than the same appendage in the adult, and is provided with a great number of ciliated bristles. It consists of two principal parts, the endognath and the exognath [scaphognathite]; they unite in a common base. In the first maxilla there is no part corresponding to the exognath. In the case of the endognath, its four lower lobes correspond to the two masticatory lobes of the first maxilla; that is to say, each lobe of the latter has been in the second maxilla divided into two—the upper uniformly, the lower unequally. The four small upper lobes along with the terminal position represent the palp (endopodite)."

The exognath is an oval plate bearing five stout densely plumose setæ. Of the latter, two are borne on the distal margin, one on the outer border, and two at the hind corner. The last or proximal seta is directed backwards in each stage.

All the lobes of the endognath are provided with one or more bristles, and these are distributed in a very definite order. The terminal portion of the endopodite bears two bristles, and proceeding downwards the successive lobes carry 1, 2, 3, 4, 4, 4, 6 bristles respectively. In the later stages the bottom lobe bears seven bristles. The bristles are of a varied nature. The terminal bristle is long and is furnished with a few long cilia. A second variety of bristle bears near its tip a fascicle of stout lanceolate tooth-like cilia, while its proximal part is adorned with a few long delicate cilia. Certain of the spines have three (in later stages a greater number) very long lanceolate cilia on one side only, and in addition they are serrated at their tips. Others are deeply serrated, and on the bottom lobes there are plumose bristles. A few are quite plain.

The bristle formula is 2 : 1 : 2 : 3 : 4 : 4 : 4 : 6.

On each side of the angle between the exognath and the endognath there is a group of cilia.

II.–V. (figs. 73, 66, 71, 81). In the stages II.–V. no change except in size takes place in the endognath. Most of the bristles, however, become minutely serrated at their tips, *vide* stages III., IV., and V., figs. 66, 71, 81.

The setæ of the exognath gradually become more numerous. The numbers found in the different stages were—I., 5; II., 9; III., 10; IV., 12 (13); V., 20. Ehrenbaum gives I., 5; II., 8; III., 12; V., 19 (in sketch). In stage IV. the maxilla on one side of the larva had 12 plumose setæ, while that of the other side had 13. In the drawing of stage III. (fig. 73) the lowermost seta has been introduced, although it was absent in the preparation, through injury.

In stage V. the cilia in the angle between the exognath and endognath were not found.

VI. (fig. 70). The exognath has undergone no change except in size and in the acquisition of a number of extra setæ, of which it has now 30 *ca.*

The endognath, however, is altered completely. It now consists of a helmet-shaped endopodite and a narrow lobe bearing at its extremity a single smooth hair.

VII. (fig 67). The exognath has now 38 *ca.* plumose setæ.

The helmet-shaped palp shows a trace of segmentation near its distal extremity. On its outer edge there are two short plumose hairs. The lower element in this stage, as in the preceding, bears a single hair.

FIRST MAXILLIPEDE (1 mp., Plates III. and IV.).

I. (fig. 78). The first maxillipede consists of a two-jointed protopodite and an exopodite and an endopodite. Claus and Sars draw attention to the great resemblance between the endognath of the first maxillipede and the corresponding part of the second maxilla.

The exopodite is much longer and stronger than the inner branch, and bears at its tip three long plumose swimming setæ. At a little distance short of the tip there is another seta. This branch, according to Ehrenbaum, is two-jointed, but that I have not found to be the case. The exopodites of the maxillipedes are the swimming organs of the larva.

The endopodite is four-jointed, according to Sars and Ehrenbaum. The last joint bears at its extremity three bristles, of which two have a few comparatively large serrations. A short bristle arises a little behind the tip on the outer edge, and on the inner surface of the third joint there is a long bristle. The second joint bears one and the first three bristles. The separation between the third and fourth joints is not very distinct.

The basipodite bears eleven bristles in all. They are arranged in three groups containing three bristles each, the remaining two being singly arranged. The coxopodite has four bristles. The bristle formula for the endopodite is 3+1 : 1 : 1 : 3 : 3, 3, 3, 1, 1 : 4.

The bristles of the endopodite and protopodite resemble those on the second maxilla (Ehrenbaum). They are nearly all supplied with lanceolate tooth-like cilia, and usually have some delicate cilia as well. Some of the bristles do not taper to a fine point, but end bluntly.

If a comparison is instituted between the second maxilla and the first maxillipede, it is seen, through the general arrangement and grouping of the bristles, that the lowest lobe of the former corresponds to the coxopodite, and the three lobes immediately above it correspond to the basipodite of the latter. The second maxilla and the three maxillipedes form a closely related series of appendages.

II.-V. (figs. 85, 86, 95, 100). The exopodite in the second stage has four terminal and one proximal seta. This number it retains during the remaining larval stages.

The number of bristles on the endopodite does not change.

On the basipodite there are in stages II. and III. thirteen bristles, the two upper groups having been increased by one each. In stages IV. (fig. 95) and V. (fig. 100, Plate IV.) a total of 14 bristles was found on the basipodite, arranged in groups of 4, 5, 3, 1, 1.

On the coxopodite in stages II.-V. five setæ were found.

In stage IV. certain of the lower bristles were serrated at tip, and in stage V. all, with but one or two exceptions, were so.

VI. (fig. 91). The bristles disappear in this stage, the appendage undergoing a great transformation.

On the outer side of the protopodite a plate, slipper-shaped in form, has appeared (epipodite).

The exopodite is geniculate, bending over the short endopodite. At its tip it bears four short plumose hairs, with a fifth a little distance behind them. A long plumose seta arises from the outer edge of its proximal half.

The endopodite, which is one-jointed, has at its distal extremity two short plumose hairs; and on its inner surface, a little in front of the middle of its length, it bears a very long and thickly plumose seta.

VII. (fig. 98, Plate IV.). In this stage no change other than an increase in size has taken place, except in the exopodite. This branch has received another short plumose hair and a plain one.

SECOND MAXILLIPEDE (2 mp., Plates III. and IV.).

I. (fig. 88). The second maxillipede differs considerably from the first pair. The angle between the exopodite and endopodite is large; the endopodite is curved inwards. The protopodite is two-jointed.

The exopodite bears three terminal swimming setæ, and two others, one on each side, close to the tip. The proximal portion is broader than the distal.

The endopodite, according to Sars and Ehrenbaum, is five-jointed. In stages IV. and V. the five joints are very apparent, but in the earlier stages they are not so; the septum between the first and second joints is sometimes difficult to make out. The endopodite and protopodite are provided with bristles. These are not, however, all so stout as those on the second maxilla and first maxillipede. At the tip of the last segment of the endopodite there are four bristles, three of which are furnished with a few large serrations. They recall the bristles borne in the same position on the first maxillipede. On the outer surface of the same joint there is a plain bristle. The upper border of the last but one joint bears two sparsely ciliated bristles. The third joint is devoid of bristles; the second bears one, and the first, three sparsely ciliated bristles on their distal borders.

The basipodite has four bristles similar to the last (in later stages five were found), and the coxopodite one bristle.

The bristle formula of the endopodite and protopodite is 4+1 : 2 : 0 : 1 : 3 : 2, 1, 1 : 1. These bristles, with the exception of the terminal group, are soft and have filamentous tips.

The exopodite is loosely jointed to the protopodite; this indicates a greater freedom of movement of the swimming branch than is afforded to the same part in the first maxillipede. In the free-swimming larva the exopodites of the second and third maxillipedes are seen to project out from the sides of the body, whereas the movements of the exopodite of the first pair are more or less hidden (Ehrenbaum). In preserved specimens also, while the former project at right angles to the side, the latter is directed forwards under the larva.

II. (fig. 93). The exopodite gains in stage II. an additional terminal seta, and remains during the rest of the larval period with six of these organs.

In this stage certain of the terminal bristles are seen to be minutely serrated at their tips. A plumose hair has appeared on the outer surface of the first joint.

The endopodite does not undergo much change in the remaining stages.

III. (fig. 92). The third-last joint, which had previously been devoid of hairs, now bears one on its outer surface.

IV. and V. (figs. 101 and 103, Plate IV.). The endopodite is distinctly five-jointed. The second joint now resembles the first and third in having on its outer distal edge a plumose hair (stage IV., fig. 101). The ciliated bristles are minutely serrated at tip, and in stage V. (fig. 103) a few minute teeth may be made out on the distal portions of the upper two plumose hairs. The bottom hair of the basipodite did not appear to be serrated at its tip.

The basipodite was found to possess five bristles in stages III. and V. The drawing of stage IV. was made from a preparation in which the protopodite had been damaged.

In the preparations of stages II. and III. two bristles were found in place of the group of three on the first joint of the endopodite, stage I.

VI. (fig. 89). The appendage in this stage assumes the condition in the adult.

The exopodite, which now has six short plumose setæ in place of the long swimming setæ of the larva, is geniculate in form and bends over the endopodite.

The endopodite is five-jointed and is bent in on itself. Its second and third joints are provided with a long and a short plumose hair respectively. The fourth joint is the longest of the five, and is, moreover, broad and massive in appearance. It bears a row of eight serrated bristles (fig. 94). Beginning at a point a little beyond the middle of the joint and on its anterior* edge, they extend on the *ventral** surface alongside the base of the terminal joint. One bristle only is on the dorsal surface. The terminal joint is elaborately armed (fig. 102, Plate IV.). It bears three long serrated thorns, three smaller dentate thorns (fig. 96), and four serrated bristles.

VII. (fig. 87, Plate III.). The exopodite in this stage has two more hairs, one plumose on the proximal, and the other plain on the distal portion. The terminal setæ are longer in proportion than in stage VI.

On the endopodite the spines of the penultimate joint are more numerous, viz., 12, and of these two are on the dorsal surface, the ten being ventral (fig. 97, Plate IV.). The last joint (fig. 99) has now four large serrated thorns and five short dentate thorns (fig. 96).

There is an *epipodite* on the outer side of the coxopodite.

Third Maxillipede (3 mp., Plate IV.).

I. (fig. 118). The third maxillipede resembles generally the second pair. The exopodite has three terminal and two lateral swimming setæ.

The endopodite is five-jointed. The second and fourth joints are considerably larger than the others (Sars), The fifth or terminal joint is very small and bears three serrated bristles. The serrations on the proximal halves of the bristles are large and few in number; on the distal halves they are minute and closely set. On the outer surface of the joint there is a plain hair. The fourth joint bears on its distal edge two serrated bristles. The bristles on other parts of the limb are slender. They are situated, one on the second joint, and two on the first joint of the endopodite. There are also two on the basipodite. The bristle formula is 3+1 : 2 : 0 : 1 : 2 : 2 : 0.

II. (fig. 121). The exopodite has gained its full complement of six swimming setæ. A hair has appeared on the third joint of the endopodite.

III. (fig. 105). In this stage the endopodite bears four terminal bristles.

IV. (fig. 111). The number of hairs on the fourth joint has been increased by one.

V. (fig. 110). Most of the bristles are seen to be minutely serrated at tip; the lower bristles are also sparsely ciliated.

VI. (fig. 104). In this stage the endopodite has increased very much in size. The exopodite is a small branch bearing six short plumose setæ; it is geniculate in form.

The endopodite consists of three joints, the first of which is the longest. It is firmly attached to the basipodite, and appears indeed to be fused with it. The line of separation is not very prominent. The endopodite is divided into a proximal and a distal part. The former is the first joint, the latter is composed of the second and third joints. These two parts are separated by a considerable interval, in a manner similar to the connection between the exopodite and the basipodite joint in the larva. This will afford to the distal part a considerable amount of free play. The first joint is characterised by a large number of plumose setæ; the second and third

* As the limb lies in the Shrimp.

joints are provided with a number of dentate thorns and with bristles. On the outer side of the first joint there is a row of five plumose setæ; and starting from the outer distal corner a second row of nine similar hairs passes across the ventral* surface of the top of the joint, and is continued down the inner† edge. Accompanying the second series there are eight short hairs, two at least of which are plumose. On the proximal part of the inner surface there is a group of four hairs, two of which are plumose and one serrated. On the dorsal surface, near the distal end of the joint, there are three long blunt teeth.

On the distal portion of the endopodite, viz., the second and third joints, groups of dentate thorns and bristles are collected at definite nodes. The dentate thorns and serrated bristles are all on the inner surface; on the outer surface there are sparsely plumose bristles. On the second joint, at a node situated a little beyond the middle, there are two dentate thorns and a bristle, and on the outer side a plumose bristle. Three‡ dentate thorns and one serrated bristle on the inner side and three sparsely plumose bristles on the outer side adorn the next node, viz., the distal end of the joint. The third joint has a conical apex and shows three well-marked nodes, at the first of which there are two thorns on the inner and one bristle on the outer side. At the next node a tendency is shown to form a whorl, but it is not complete, the dentate thorn and its three bristles being separated by an interval from the group of four outer bristles. All the bristles at this node with one exception are sparsely plumose. It is to be noted that the dentate thorns vary in size, and they do not all show the same amount of surface; some are seen in front view, while others are set edge on. At the third node there is round the base of the cone a complete whorl of bristles (13 *ca.*), which are all sparsely plumose (fig.123). At the top of the cone there is a little whorl of six short plumose bristles surrounding a little apical process.

The movable distal part of the endopodites of both sides will probably interact on one another by means of their thorn-armed inner surfaces.

The basipodite joint bears eight bristles, certain of which are plumose, others serrated.

An epipodite is present on the coxopodite.

VII. (fig. 124). The thorns and bristles have increased in number.

The exopodite has two additional plumose setæ (figs. 124 and 106).

The separation between the basipodite and the first joint of the endopodite is no longer distinct.

A considerable increase has taken place in the number of plumose setæ and bristles serrated and plain on the first joint. In fig. 116 the inner surface of the first endopodite joint and the basipodite is shown; and in figs. 115, 114, 113, the armature of the second and third joints may be seen. The general arrangement noted in the sixth stage is still followed. There has been an increase in the number of thorns; three more, at two new nodes, have appeared on the second joint. At the other points the numbers remain the same as in the preceding stage. The drawing represents the maxillipede of the right side, and in this case there are four thorns at the top of the second joint, as in the appendage of the same side in stage VI. The bristles (11 *ca.*) accompanying the topmost thorn now form a complete whorl. Of these bristles two only are serrated. The whorl at the base of the cone consists of 16 *ca.* bristles (fig. 114). None of these are serrated. At the apex there

* As the limb lies in the Shrimp.

† That is next the third maxillipede of the other side.

‡ On the third maxillipede of the left side there were four thorns at this point.

are seven serrated bristles (fig. 113). A small apical process is still present.

Figs. 112, 109, 117, 119, 120 represent various hairs and thorns on the endopodite.

TELSON (T, Plates I. and II.).

I. (fig. 4). The telson is not completely divided off from the sixth abdominal segment. It is roughly triangular in shape, and its hind border shows four distinct lobes, two on either side of the shallow median cleft. It is furnished with 14 spines, of which three are attached to each lobe; the remaining two are situated one on each side of the telson near the outer angle. The lateral spines are the smallest, and the two inner spines belonging to the outer lobe are the longest. The spines are all similar in structure (fig. 5). They are strong, tapering to falcate tips, and are furnished with cilia and serrations, the rows of teeth and cilia being apparently alternate. The terminal cilium arising from the base of the falcate portion is thicker and more prominent than the others. The innermost spine, that next the median cleft, would appear to be ciliated on the inner side only.

The hind border of the telson is also furnished with teeth (fig. 16). On the dorsal surface at the base of each spine, with the exception of the outermost, there is a group of triangular teeth (*cf.* Ehrenbaum, *fig. 50*). The number of teeth to each spine varied with the spines and also with the different stages. The number found in the specimen examined has been introduced in the drawing of each stage. Between the bases of the spines minute teeth were seen on the hind border or on its ventral edge. As in the case of the basal teeth, those reproduced in the drawing were all that were observed in the preparation. On the median cleft, in addition to the teeth, there are one or two short delicate hairs, and on the dorsal surface behind there is a row of small teeth.

The rudiments of the uropods are seen at the proximal portion of the telson on either side of the anus (ur., fig. 4).

Sars and Ehrenbaum give detailed descriptions of the telson and its spines.

II. (fig. 13). The telson has in this stage gained two spines, making 16 in all (Ehrenbaum). They have developed one on either side of the median cleft (sp., fig 5). This figure shows a telson of a larva of stage I. just before casting; the telson of stage II. is seen within. In stage II. the telson differs little from that of stage I., except in the possession of 16 spines, and in the reduction in the size of the median cleft. The structure of the spines, their armature, and ciliation are exactly similar.

Fig. 8 shows the number of the teeth on the hind edge of the telson.

The separation of the telson from the sixth abdomial segment has now taken place.

The rudiments of the uropods are more prominent (ur., fig. 13).

III. (fig. 7). The telson is practically identical, except in size, with that of the preceding stage.

The uropods appear externally for the first time (Ehrenbaum). The uropod consists of a basal joint and an outer and an inner branch; both the latter are small, the inner especially so. The exopodite terminates on its outer border in a single strong tooth; its anterior margin is furnished with six plumose setæ. Close to the lateral tooth there is a short plain hair, and next it comes the first plumose seta, which is very small. On the *ventral* surface of the outer branch there are four feathered hairs (fig. 20). The inner branch is furnished with five marginal plumose setæ; of these,

three are terminal, and two on its inner edge. Of the three terminal setæ, the outermost is very small. On the *dorsal* surface of the branch there are two feathered hairs. The uropods are shorter than the telson.

The hind margin of the sixth abdominal segment is prolonged posteriorly into two lateral teeth, one on each side of the base o the telson and above the basal joint of the uropod.

A small swelling on the ventral surface, a little in front of the anus, is the rudiment of the anal spine (*sp.*, fig. 17).

IV. (fig. 1). This stage is mainly characterised by the development of the uropods. They have increased considerably in size and bear a greater proportion to the telson than formerly. The outer element bears 12, and the inner element nine marginal plumose setæ (fig. 21). A number of hairs have appeared on the surface of the uropod. These are on the ventral surface of the exopodite, with the exception of two on the outer edge, and on the dorsal surface and outer edge of the endopodite.

The telson retains much the same shape as in the preceding stages.

The anal spine is present but small (sp., fig 1).

V. (fig. 3). The telson in this stage is oblong in place of being triangular. It has lost in breadth in its distal portion, and gained in length by what is practically an outpushing of the six spines on each side next the furca, which has almost disappeared, and the consequent transference of the second outer spine on each side to a lateral position. In this stage no teeth were made out on the dorsal surface of the telson at the base of this, the seventh spine counting from the furca, although they were present in the three preceding stages (fig. 19). Its lateral, in place of its former terminal, position on the telson may have some bearing on the absence of the teeth. In the preceding stages the only spine at the base of which there were no dorsal marginal teeth on the telson was the single lateral spine.

Accompanying an increased size the marginal plumose setæ of the uropods are more numerous, on the outer branch (fig. 31) numbering 16, on the inner (fig. 25) 14. The number of hairs on the ventral and dorsal surfaces of the two branches has not increased much. Of those on the endopodite most were feathered.

The anal spine is very prominent, and remains in all the succeeding stages.

VI. (fig. 2). On casting from stage V. certain of the spines of the telson disappear (fig. 32). (*Vide* Sars.) Counting from the median cleft outwards, the 1st, 5th, 6th, 7th, and 8th spines of the stage V. appear again as spines in stage VI. (Ehrenbaum). Spines 2nd, 3rd, and 4th, the group of three attached to the inner lobe in stage I., are represented in stage VI. by No. 2, which persists as a short slender hair close to the terminal spine of the telson (*vide* Sars). Small rudiments of Nos. 3 and 4 are seen immediately on casting (fig. 10), but they soon disappear. A small process takes the place of the furca. The telson of stage VI. is the result of a continued outpushing, begun in stage V. An intermediate condition is seen in figs. 10 and 6, which represent the telson of a form which is in the act of casting; the abdomen was freed from its integument, but in the cephalic region moulting was not complete. The end of the telson was swollen into a globular shape; the dorsal view is shown in fig. 10, the side view in fig. 6.

The telson (figs. 2 and 30) is now narrower posteriorly than it is at its base, and in later stages it becomes still narrower. It tapers gently from its base to its distal part. The sides here turn inwards to form the rounded termination bearing a small process, flanked on either side by a ciliated spine, the persistent first spine of the preceding stage. At its

base there arises a delicate plain hair, and on the inturned edge of the telson there are attached a long and a short plain spine. On the side of the telson are two other short thick spines similar to the preceding. The two long spines—viz., the terminal ciliated, and the long plain spine—are directed backwards and outwards.

The uropods are thickly provided with marginal plumose setæ, the exopodite (figs. 2 and 43) with *ca.* 23, the endopodite (figs. 2 and 26) *ca.* 20. The outer edge of the exopodite terminates in two teeth (fig. 14), of which the outer is the shorter of the two. A small plain hair arises on the dorsal surface from the base of the smaller tooth. On the ventral surface and outer edge of the exopodite there is a large number of hairs, most of which, with the exception of the two proximal hairs on the outer edge, appear to be plain. On the dorsal surface there are three long ciliated hairs. On the endopodite the hairs are on the dorsal surface, with the exception of one on the inner edge near the base.

On the dorsal surface of the telson (fig, 30) there are a number of hairs arranged in pairs. There are six principal pairs and four hairs on each side of the double median row. There are also two lateral hairs on each side, one near the base, the other close to the more anterior of the lateral spines.

VII. (fig. 15). In this stage there is little change from the preceding, except that the distal end of the telson is a little narrower in proportion, and the long spines are pointed directly posteriorly (figs. 15, 27, 28, and 35). The latter are curved with the convex side outwards. The terminal spines have their distal fourths bare of cilia. There are seven pairs of hairs on the median portion of the telson, the second pair from the base being the longest (fig 35). There is also a row of smaller hairs along either ventral edge, and three teeth, somewhat hastate in shape, on each side of the proximal portion (dorsal).

The marginal plumose setæ of the uropods have increased in number—viz., on the exopodite (fig. 28) 28 *ca.*, on the endopodite (fig. 27) 29 *ca.* On the exopodite almost all the surface hairs are ventral; those along the outer edge are dorsal. The hairs along the inner edge are mainly ciliated, while those on the outer side are, with the exception of those at the base, plain. There are five long hairs on the dorsal surface of this branch. On the inner branch the hairs are on the dorsal surface, and for the most part feathered. One hair—viz., at the base on the inner side—is ventral.

Pereiopods (*per.*, Plate V.).

I. (figs. 126 *a* and *b*). The pereiopods are represented in the first stage by a group of buds situated on each side immediately posterior to the third maxillipede. They are five in number, and bend in towards the middle line. The figure (126 *a*) shows a ventral view. The first bud is bifid, seen in side view in fig. 126 *b*. The second is small, and is situated a little nearer the middle line than the others; it lies to the inside of the first. The third and fourth are more prominent than the fifth, which appears to be smaller; it is sometimes with difficulty made out, especially in side view. As the thorax narrows rapidly behind the maxillipedes. the buds stand in a curve on either side.

According to Sars there is in the first stage of Crangon only one bud; the remaining four buds appear together in the second stage. Claus* stated that there were two pairs of pereiopods in the larva of Crangon

* Claus, "Zur Kenntniss der Malacostrakenlarven," *Wurzburger Naturw. Zeitschr.* 1861.

when hatched, the rudiments of the three other pairs developing soon after. Ehrenbaum says that there are three, sometimes four, buds, the first of which is biramose, in the larva of the first stage. The earliest prelarva of *Palaemonetes vulgaris* shows the rudiments of the two anterior pairs of pereiopods, while the posterior pairs arise independently in succeeding stages (W. Faxon).* In the zoëa stage of *Lucifer* there are only buds of four pereiopods.† In the zoëa of *Penaeus* there are rudiments of the five pereiopods.† In *Pandalus borealis* the first larval stage observed by Sars had the bud of one pereiopod only.‡

II. (fig. 135). In this stage the buds have increased much in size. The exopodite and endopodite of the first are now distinctly different from one another. The endopodite is club-shaped; the exopodite is longer than the former and tapers a little. The bud of the second limb is small and lies a little behind and on the inner side of the first. The third, fourth, and fifth are clavate in shape, and are bent inwards and forwards, each in succession lying on the inner side of the one which precedes it.

III. (figs. 137 *a* and *b*). The first limb has developed considerably. The exopodite now resembles the exopodite of a maxillipede. It is furnished with the usual six swimming setæ. The endopodite is similar in form to that of the preceding stage, but it now bears a short terminal hair.

The second, third, fourth, and fifth remain in shape as in stage II.

IV. (figs. 147 and 145). The exopodite of the first pair remains unchanged in structure; the endopodite is now four-jointed. The third joint is very large, and is the future propodite. The end joint bears the single hair at its tip, while on the distal edge of the third joint there are two hairs, one on each side. The second limb is cylindrical in shape and bears a terminal hair. The third, fourth, and fifth have now begun to assume the shape of the walking limbs. They are all two-jointed, the short terminal joint representing the future propodite and dactylopodite.

V. (fig. 139). In this stage the pereiopods have become fully jointed. The first, which still retains its swimming exopodite, has a two-jointed protopodite; the endopodite is five-jointed. The normal number of joints is thus present, seven—viz., the coxopodite and basipodite forming the protopodite, and the ischiopodite, meropodite, carpopodite, propodite, and dactylopodite. The dactylopodite is now claw-shaped and possesses a rudimentary cutting edge. The second limb already shows a rudimentary chela tip, the dactylopodite of which bears a single hair. The third, fourth, and fifth limbs, like the preceding, have their full complement of joints.

VI. In this stage all the pereiopods are functional.

First Pereiopod. Figs. 138, 125, 128, 132, 140, 149, 151. This limb is now in form almost identical with the adult appendage. The exopodite has degenerated, and is present only as a small process on the outer side of the basipodite (*ex.* figs. 138 and 128). The endopodite functions as a cutting organ, the dactylopodite being freely movable, and forming with the knife-edge on the protopodite an effective shears. The joints of the limb are adorned with a few hairs and thorns. The hairs are on the inner side mainly, and are borne by all the joints; those on the three first joints are plumose. The meropodite is a long joint terminating on its outer border in a large hook. On the inner edge there is a small

* Faxon, "On the Development of *Palæmonetes vulgaris*." *Bull. Mus. Comp. Zool. Harvard Coll.* Cambridge, Mass., Vol. V., 1879.

† Korschelt and Heider. Text-Book of the Embryology of Invertebrates. London, 1899.

‡ *Report of Norwegian Fishery and Marine Investigations*, Vol. I., No. 3. Christiania, 1900.

notch (*n*) in some of the young forms of this stage; it is not present in all. The carpopodite is a short roundish joint (fig. 125). It is armed on its inner surface with three thorns, of which two are dentate. On its ventral or posterior surface it bears a tooth, close to the base of which a hair arises. The hand (propodite) is likewise armed with dentate thorns on the base of its inner side. They are four, sometimes five in number. The deep cutting edge of the hand ends in a large hook. Along each side of the blade there is a row of four stiff hairs which are curved backwards towards the hinge. The dactylopodite, which has a narrow knife-edge, acts upon the blade of the hand in the manner of a pair of scissors, but with this difference, that its curved end crosses over in front of the hook and drops down on its opposite side. In this way the two blades are locked together (figs. 151 and 149). The knife-edge of the claw does not extend along its whole length, but ends at some distance short of the tip, the hooked termination not functioning for cutting, but merely for locking the two parts (fig. 132). In the claw there is a number of fine tubes, nine in all, which open out on to the cutting edge (fig. 132). In the hook of the propodite also there are two (or three) of these tubes (fig. 140). It is possible that by these tubes a lubricant of some sort is poured on to the blade.

Certain differences were noticed in the first pereiopod of different young forms of this stage. As was mentioned above, the number of joints in the flagellum of the antenna is not constant. In a form which had 19 and 20 joints in the flagella of its two antennæ, the dactylopodite of the first pereiopod (fig. 149) was longer than that joint in a shrimp which had 17- and 18-jointed flagella. While in individuals of the former class the little notch on the inner side of the mesopodite was present, it was not made out in the latter. In one case five dentate thorns were found on the base of the hand in a young shrimp having 19 joints to the flagellum of the antenna; in one having 17 joints to the same only four were found. At first sight these differences might be considered sexual, since a difference in the size of the dactylopodite may be seen in adults of different sexes, but the investigation has not been carried far enough to warrant any definite conclusion.

VII. (figs. 144, 142, 141). The remnant of the exopodite has disappeared. A few hairs have been added to the limb, mainly on the meropodite and hand. On the surface of the latter a few short hairs have appeared. Along each side of the knife-edge of the propodite there is now a row of five hairs. The thorns on the carpopodite are of the same number as in the last stage—viz., three (fig, 142). The tooth, *t*, is larger. On the hand there are six dentate thorns. The notch on the inner edge of the meropodite is prominent (*n*, figs. 142 and 144).

Second Pereicpod. VI. (2, fig. 134). The second pereiopod, which ends in a chela tip, is slender, and in its full extent little shorter than the other pereiopods (Ehrenbaum). It is situated nearer the middle line and close up to the first pereiopod (Plate VI., fig. 187, 2), and is always folded upon itself. The joints are all of about the same thickness. The coxopodite joint bears an epipodite. The limb is furnished with only three hairs; they are in the basipodite—viz., two plumose hairs on the distal border, and one plain hair at the middle of the joint. The chela is composed of two hooked jaws, the dactylopodite being slightly longer than the propodite part (fig. 143). It is adorned with several short curved spines, three on each half of the chela. One of these at least is serrated, but on the concave side only. There is also a number of long bristles, four of which are on the dactylopodite and two on the hook of the propodite. On the latter, a little behind the hook, there are two other bristles, while three

are arranged round the hinge, two on one side, and the third on the other.

VII. (fig. 127). The limb in this stage varies little from the condition in stage VI. The armature of the chela has increased (fig. 129). The little curved spines are more numerous, there being five each on the dactyl and hook of the propodite. These are all serrated on their concave sides. A plain short bristle was also present on the latter. The long bristles, which are the same in number as in stage VI., are all strongly serrated on both sides.

THIRD, FOURTH, AND FIFTH PEREIOPODS. VI. (figs. 134, 148, 130, 150). They are of the usual form of the walking limbs of the higher decapods (seven joints), and are adorned with a varied collection of plain and ciliated hairs, and short plumose setæ. While in general closely resembling each other, the third differs from the fourth and fifth in two not unimportant points—viz., the structure of the dactylopodite, and the arrangement of the hairs borne by the limb. The joints of the fourth and fifth pereiopods are far more richly furnished with hairs than those of the third limb. They are located on the anterior, dorsal, and posterior surfaces. On the two hindmost limbs the hairs are practically identical in number and distribution. The ciliated bristles are dorsal in position generally. On the distal border of each joint there is a group of hairs, especially prominent on the ischiopodite, meropodite, and propodite. The coxopodite is furnished with long ciliated bristles. The longest are, however, on the ischiopodite. On this joint and the propodite are situated a number of short plumose setæ. They are in the latter arranged in two rows—one on the anterior, the other on the posterior surface. The group of eight hairs at the distal end form an almost complete circle round the joint; none appeared to be on the ventral edge. The dactylopodite is a long claw-like joint; it is described by Ehrenbaum as ending in "a tuft of extremely fine short hairs." This description is not strictly accurate. It is true for the third pereiopod (fig. 148); but in the fourth and fifth pereiopods the dactylopodite ends in a hook (*h*), over which projects a hood of delicate integument (figs. 131 and 150). From the ventral side of this hood issues a number of hairs which are of the nature of sensory filaments. They can be followed (*t*) some short distance back into the dactylopodite. In the fourth limb seven of these sensory filaments were found; in the fifth, six were observed. The dactylopodite of the third pereiopod does not end in a hook. From the delicate hood 14 filaments issued. As has been already mentioned, the third limb is, in comparison with the fourth and fifth, but sparsely adorned with hairs. Their number and distribution are shown in *3*, fig. 134. The third pereiopod moreover appears to have less freedom of movement about its long axis than the third and fourth; the latter appear to be able to rotate through a greater arc than the former.

On the proximal part of the ischiopodite a septum (x, fig. 134) is seen; it is not so well marked as the separation between two joints, and is probably the fracture plane. It is present in the adult. Fredericq,* however, says that in *Carcinus maenas* the fracture plane is at the suture between the basipodite and ischiopodite.

VII. (fig. 146). The three pereiopods do not call for detailed description in this stage. The resemble almost exactly those of stage VI., except that the number of hairs on each is increased. Their position and number are shown in the figure. The short plumose setæ on the protopodite are in a row running in a slanting direction along the posterior surface of the joint. Enlarged drawings of the bristles and setæ are shown in figs. 136,

* "Nouvelles recherches sur l'autotomie chez le Crabe." 1891.

133, and 130. On the dactylopodites were found—3rd, 15 filaments: 4th, 6 (? 7); 5th, 6. A small tooth, *t*, has appeared on the posterior surface of the distal part of the meropodite in the fourth and fifth limbs.

The Pereiopods of the Adult.

The filaments on the tips of the dactylopodites of the 3rd, 4th, and 5th pereiopods are not peculiar to the young form; they are present in the adult. Figures 191, 193, and 196 show the tips of the dactylopodites of the 3rd and 5th pereiopods. As in the sixth stage, the 4th and 5th pereiopods end in membranous prolongations of the ventral wall of the last joint, and over and in front of them the dorsal wall of the same projects as a soft hood. From within this hood issue the sensory filaments. They are more numerous than in the larva, there being on the 5th pereiopod fourteen processes. In the case of the 3rd pereiopod there is no ventral terminal process (fig. 191).

Pleopods (pleo., Plates V. and VI.).

I. (fig. 184). The rudiment of the pleopod may be seen in the first stage. On the ventral surface of the first five abdominal joints there are little swellings within which the rudiments of the pleopods may be traced.

II. and III. (figs. 157, 167, 183). The swellings are more prominent, but the pleopod does not project externally.

IV. (fig. 169). In this stage they project as little buds on each side of the gut.

V. (fig. 176). The pleopod is two-jointed. The second joint, which is spatulate, is the exopodite. The endopodite is represented by a small rounded process on the distal border of the first joint.

VI. (figs. 172, 171, 168, 185, 173, 161). The swimmerets are biramose and provided with long setæ. The exopodite, which is paddled-shaped, is convex on its anterior surface and concave on its posterior. It bears 15 setæ, two of which are terminal, six on the outer edge, and seven on the inner. The fifth swimmeret, which is the smallest, has 13 setæ only (fig. 173). The setæ of the pleopods are of two kinds: on the outer border and the tip they are densely plumose; on the inner border they are furnished with long lanceolate cilia on the proximal side. On the distal side of the latter setæ the ciliæ are long and slender, and resemble the cilia which are present on the setæ on the outer side of the pleopod. The lanceolate cilia are stoutest in the setæ next the base, and become less stout the more distal the seta. That is, in passing from the base towards the tip, the cilia of the one side become in each less tooth-like until the seta is symetrically supplied on both sides with delicate cilia identical with those on the outer setæ This happens in the fifth seta. The setæ are segmented, with the exception of the three lower setæ on the outer side. On the outer side the joints are not so well marked as on the inner. The proximal half is usually unsegmented, the distal half is broken up into four to seven joints. The number of setæ varies, thus in the fourth pair of swimmerets, on one side there were six outer setæ and on the other five.

There are two short hairs on the inner border of the anterior surface.

The endopodites are small rounded knobs bearing two bristles, one of which is plain, the other, which is the longer, is furnished with long flat teeth. On the first swimmeret the endopodite is very small and bears two plain bristles (fig. 172).

VII. (figs. 181, 166, 162, 164, 175). The number of setæ has

increased, there now being, in addition to the two terminal setæ, seven outer and eight inner, 17 in all. On the fifth swimmeret there is one seta less on each side, viz., six outer and seven inner. The endopodites (figs. 165, 178, 177, 179, 182) are furnished with two serrated and one plain bristle. On one of the swimmerets of the fifth pair there were three serrated and one plain bristle (fig. 174). The endopodite of the first pleopod is surmounted by two plain bristles (fig. 165).

THE EYES (o, Plates V. and VI.).

The eyes in the larval stages are sessile: they are lateral in position and very large. The nauplius eye is present as a small black patch between the two compound eyes.

I. In the first stage the facetted cornea of the eye is a specialised portion of the carapace, which is bulged out over the projecting eye. *Vide* fig. 159, which is a drawing of a moulted carapace of the first stage. Ehrenbaum describes the condition thus:—"Sie [die Augen] erscheinen hier unter dem Rückenschilde liegend, dessen Konturen mit denen der Mittellinie des Körpers zusammen." * He does not mention the facetted condition of that part of the carapace. Dohrn † describes a larva in which a similar condition was found, as follows:—"Die grossen zusammengesetzen Augen in dem vorderen Theile des Schildes eingewachsen sind, so dass die äusseren sechseckigen Facetten eine Fortsetzung des Schildes sind." That this is a case of secondary attachment of the cornea to the carapace does not seem likely; it is more probable that this condition indicates the development of the cornea from a specialised anterior portion of the carapace.

II.—V. (figs. 157, 167, 170, 158). In stage II. the eye is free from the carapace, and in the succeeding larval stages there is practically no change except increase in size.

VI. (fig. 186). The eyes are now stalked and freely movable. They are directed anteriorly and outwards in contradistinction to the larval eye, the facets of which are more lateral. There are two short hairs on the inner edge of each eye, close to the rostrum. The nauplius eye is still present (Ehrenbaum).

VII. (fig. 195). On the border of the facetted portion of the cornea there are two protuberances, with one of which, situated on the dorsal surface of the eye, there are associated three short hairs. Of these, one is on the apex, the others are at either side of its base. The second protuberance is without hairs. On the proximal part of the inner side of the eye there is a short hair.

BRANCHIÆ (g, Plate V.).

The gills are first recognised in stage IV., in which stage they appear as five rounded protuberances. Ehrenbaum states that they number four only, and that "the fifth gill is a little later in development than the others, in like manner to the fifth pair of pereiopods." The buds of the gills are connected with the bases of the pereiopods (figs. 145 and 170), that is to say, they are in the present stage *podobranchs*.

In stage V. (fig. 139), the gills are larger, but show no segmentation into leaves externally, although the traces of division may be seen within the plain cuticle. Each gill is now connected with the integument joining the protopodite of the pereiopod to the thorax, and is therefore at this stage an *Arthrobranch*.

* *Op. cit.*, p. 59.

† Dohrn. "Untersuchungen über Bau und Entwickelung der Arthropoden," Zeitschrift f. wissenschaftliche Zoologie, von Siebold und Kölliker, Bd. 21., 1871, p. 377.

In stage VI. the gills have become spindle-shaped and divided into lobes. Each is composed of nine (*ca.*) leaves, of which all but the leaf at either end are bi-lobed (fig. 134). The fifth gill is smaller than the others.

In stage VII. the gills are now removed from the vicinity of the bases of the limbs and are situated some distance up on the epimera; in other words, they are now pleurobranchs. They are apparently all of one size in this stage.*

The Zoëa.

The zoëa of the shrimp differs from the parent form, principally in respect to the structure of certain of its appendages; and these are, those which are concerned in feeding (viz., the mandibles, maxillæ, and maxillipedes), and those subservient to sensation, *e.g.*, endopodites of the antennule and antenna. The latter do not function as sensory organs in the zoëa. The larva is provided with organs which enable it to procure food in a manner quite different from that proper to the adult. It is an automatic feeder, and very few, if any, of its movements are co-ordinated. Its swimming organs, the exopodites of the maxillipedes, simply serve to keep it from resting continually in one spot, and by them it is ever brought into contact with fresh supplies of food material. The latter no doubt consists of diatoms and the larvæ of invertebrates. In the case of the adult, which feeds largely on other adult forms, *e.g.*, annelids, amphipods, etc., the manducatory appendages are quite different from those of the larva, *cf.* Plates II., III., IV. In the sixth stage it enters on a new mode of existence; it assumes a bottom habitat, its sensory organs are fully developed, it feeds consciously, and its actions are co-ordinated and more or less purposed.

During the zoëa period the limbs, which are not present on hatching, appear and develop. They are numerous and of intricate structure, and in consequence a large quantity of food is required for their formation. The functional appendages with which the zoëa is furnished in its first stage remain unchanged during the zoëa period, while the pereiopods, pleopods, etc., develop regularly. The larva passes through five stages, and in each of these the pereiopods and pleopods gain a step in development towards their functional condition. For the zoëa appendages the larval period is simply *one developmental stage*. It is as if the manducatory and cephalic appendages were more precociously developed, arriving in the first zoëa at a homologous stage to that which the pereiopods and pleopods reach only in the fifth zoëa; and so during the larval period the former mark time. Then in the sixth stage all the appendages of the shrimp appear simultaneously and for the first time as functional limbs. The zoëa stages are a period for the development of the pereiopods, pleopods, and uropods.

Although complicated in structure the zoëa is of very simple form when compared to the first young stage. The precocious development of the feeding organs follows as a consequence of the small amount of yolk contained in the egg of the shrimp. The food material therein stored is not sufficient for the development of a fully formed young shrimp, and a larval stage in which food may be obtained from the surrounding medium is necessitated. In Astacus, the egg of which is large, the young form has, on hatching, all the characters of the adult. But in marine decapods a shorter or longer zoëa period is necessary before the adult appendages

* Observations such as these on the origin of the gills and their change of place with growth have been made but seldom, and, indeed, we only recall as a parallel the single observation of Claus in the case of *Penæus* (Neue Beiträge Z. Morphol. d. Crustaceen, *Arb. a. d. Zool. Inst. Wien*, VI., 1886, p. 44), a case entirely similar to the above. Both observations lead to the very important result that the gills are in all cases appendages of the limb, and that the terms arthrobranchiæ and pleurobranchiæ have no primary morphological significance.—[D.W.T.]

are developed. The lobster (*Homarus americanus*)* has a zoëa period of three stages. The length of the zoëa period probably depends on the size of the egg and on the quality of the yolk. The greater the ovum the larger is the larva, and probably also the further advanced will its development be. An analogous comparison might be drawn between the larva of the sprat (*Clupea sprattus*) and that of the herring (*Clupea harengus*). The egg of the latter is much larger than that of the former, and its yolk is, moreover, more concentrated.* The larva of the herring is larger and at a more advanced stage of development than the newly hatched sprat.

During the larval stages of the shrimp certain slight changes do take place in the structure of the functional appendages. These have been detailed in the preceding part of the paper, but they are so slight that they do not result in any change in function.

The metamorphosis in the higher crustacea has been given an importance which it probably does not deserve. The extent of the metamorphosis is not so great as in some of the other marine invertebrate groups; it has derived its apparent importance from the highly specialised structure of the zoëa. The transition from the zoëa to the young form is not nearly so striking as that from a Pilidium larva to a Nemertean, from a Bipinnaria to a Starfish, or from a Veliger to a Mollusc.

* Herrick, "The American Lobster," *Bull. U.S. Fish Commission* for 1895. Washington, 1895.

LITERATURE.

In addition to the works mentioned in the text, the following papers have been consulted :—

SPENCE BATE.—"On the Development of Decapod Crustacea." *Phil. Trans.* Roy. Soc., Vol. 148, p. 589. London, 1859.

BROOKS AND HERRICK.—"The Embryology and Metamorphosis of the Macroura." *Memoirs, Nat. Academy of Sciences,* Vol. v., p. 325. Washington, 1891.

CANO.—"Sviluppo postembrionale dei Cancridi." *Mittheil. Zool. Stat. Neapel.* Bd. 9.

CANO.—"Sviluppo postembrionale di Doripedei, Leucoredi, Corystidei, e Grapsidi." *Memorie di Mat. e di fisica, Societa Italiana delle Scienze.* Napoli, 1892. T. viii.

COUTIÈRE.—"Les Alphéidae, Morphologie externe et interne, formes larvaires, bionomie." *Ann. Sc. Nat. (Zoologie)* (8), T. 9, p. 1-559. 1899.

FAXON.—"On some young stages in the development of Hippa, Porcellana, and Pinnixa." *Bull. Compar. Zoology, Harvard,* Cambridge, U.S.A., Vol. v., p. 253. 1878-1879.

FAXON.—"Selections from Embryological Monographs, I. Crustacea." *Memoirs Museum Compar. Zoology, Harvard,* Vol. ix., No. 1. Cambridge, 1882.

GERBE.—"Metamorphoses des Crustacés marins." *Comptes rendus de l'Acad, d. Sc.,* T. 62, p. 1024. Paris, 1866.

HUXLEY.—"The Crayfish."

KINAHAN.—"Synopsis of the Species of the Families Crangonidæ and Galatheidæ." *Proc. Roy. Irish Society,* Vol. viii. 1861-1864.

P. MAYER.—"Carcinologische Mittheilungen." *Mittheil. Zool. Stat. Neapel,* Bd. 2, p. 197. 1881.

PARKER.—"The Histology and Development of the Eye in the Lobster." *Bull. Mus. Compar. Zoology, Harvard,* Cambridge, U.S.A., Vol. xx., 1890-1891, p. 1.

STEBBING.—"A History of Crustacea: Recent Malacostraca," *International Science Series,* Vol., lxxiv., London, 1893.

WARRINGTON.—"Observations on the Natural History and Habits of the Common Prawn (*Palaemon Serratus*)." *Annals of Natural History* (2), Vol. 15.

WILLEMOES-SUHM.—"Preliminary remarks on the Development of some Pelagic Decapods." *Proc. Roy. Socy.,* Vol. 24. London, 1876.

* Fulton, "On the Maturation and Growth of the Ovarian Eggs of Teleostean Fishes," *Sixteenth Annual Report of the Fishery Board for Scotland,* Part III., p. 113.

EXPLANATION OF THE PLATES.

Each figure in a plate is labelled by means of one or more letters, and a Roman numeral. The letters serve to distinguish the appendage, and the numeral indicates the larval stage to which it belongs.

The drawings have all been outlined by means of the *camera lucida*.

None of the drawings are diagrammatic; the exact nnmber of hairs, bristles, etc., observed in the preparation are shown in each sketch. A little circle at the base of a hair indicates that the hair is on the ventral surface of the sketch.

The Letters Used.

a.—antennule.
A.—antenna.
ab.—abdomen.
an.—anus.
1 b, 2 b—basal joints of endopodite of antenna.
basi.—basipodite.
c.—cilia.
car.—carapace.
carp.—carpopodite.
cox.—coxopodite.
en.—endopodite.
ep.—epipodite.
ex.—exopodite.
f. 1 & 2.—first and second joints of flagellum.
g.—branchia and also ganglion.
h.—hook.
in.—intermediate dorsal integument between the carapace and first abdominal segment.
k.—keel of rostrum.
kn.—knob on ventrum of abdominal segment.
lb.—labium.
lr.—labrum.
lsp.—lateral spine of carapace.
1 m.—first maxilla.
2 m.—second maxilla.
mn.—mandible.
1 mp.—first maxillipede.
2 mp.—second maxillipede.
3 mp.—third maxillipede.
msp.—median spine of carapace.
n.—notch.
o.—eye.
1-5 per.—five pereiopods.
1-5 pleo.—five pleopods.
pr.—prolongation of ventral wall of dactylopodite (figs. 193 and 196).
prop.—propodite.
s.—seta.
sp.—spine.
t.—tooth.
T.—telson.
Th.—thorax.
ur.—uropod.
x.—septum on ischiopodite (figs. 134 and 146).

LIST OF FIGURES.*

The magnifications (in diameters) given below are only approximate.

Plate I.

Fig. 1. Telson, IV., ... ×80
Fig. 2. ,, VI., ... ×40
Fig. 3. ,, V., ... ×40
Fig. 4. ,, I., ... ×70
Fig. 5. Half of hind border of telson, I., dorsal.
Fig. 6. Telson, VI., side view.
Fig. 7. ,, III., ... ×40
Fig. 8. Half of hind border of telson, II., dorsal.
Fig. 9. Terminal lateral spine of exopodite of uropod, VII.
Fig. 10. *Vide* fig. 6., front view.
Fig. 11. Half of hind border of telson, III., dorsal.
Fig. 12. Tips of endopodite of uropod, VI., just cast, showing setæ not yet evaginated.
Fig. 13. Telson, II., ... ×70
Fig. 14. Terminal lateral spine of exopodite of uropod, VI.
Fig. 15. Telson, VII., ... ×40
Fig. 16. Half of hind border of telson, I., dorsal.
Fig. 17. Telson, III., ventral, anal region.
Fig. 18. Part of hind border of telson, II., dorsal, showing bases of the spines.
Fig. 19. Half of hind border of telson, V., dorsal.
Fig. 20. Uropod, III., dorsal.
Fig. 21. ,, IV., ,,
Fig. 22. Exopodite of uropod, VI.
Fig. 23. Endopodite ,, ,,
Fig. 25. ,, ,, V., dorsal.
Fig. 26. ,, ,, VI., ,,

* A considerable number of the figures have, unfortunately, been placed by the lithographer upside down.

Fig. 27. Endopodite of uropod, VII., dorsal.
Fig. 28. Exopodite ,, ,, ,,
Fig. 29. Half of hind border of telson, IV.
Fig. 30. Telson, VI., dorsal.

PLATE II.

Fig. 31. Exopodite of uropod, V., dorsal.
Fig. 32. Telson of larva of fifth stage preparing to cast.
Fig. 33. Mandible, II., ... ×230
Fig. 34. ,, VII., ... ×150
Fig. 35. Telson, VII., dorsal.
Fig. 36. Scaphognathite, 2nd maxilla, V.
Fig. 37. Mandible, VI., ... ×150
Fig. 38. ,, III., ... ×150
Fig. 39. ,, IV., ... ×140
Fig. 40. ,, I., ... ×150
Fig. 41. ,, V., ... × 80
Fig. 42. Hind portion of telson, VI.
Fig. 43. Exopodite of uropod, VI., dorsal.
Fig. 44. Tip of exopodite of antennule, V.
Fig. 45. Antennule, V., ... × 40
Fig. 46. 20-jointed flagellum of antenna, VI.
Fig. 47. Anterior part of scale of antenna of larva, I., about to cast.
Fig. 47*a*. ,, ,, ,, ,, ,, ,,
Fig. 48. Tip of endopodite of antenna, V.
Fig. 49. Antenna, VII., ... × 40
Fig. 50. ,, V.
Fig. 51. ,, I., ... ×150
Fig. 52. Antenna, VI., 17-jointed flagellum, VI., ... × 40
Fig. 53. End joint of flagellum of antenna, VII.
Fig. 54. Antennule, VII., ... × 80
Fig. 55. Antenna, III.
Fig. 56. Antennule, II., ... ×150
Fig. 57. End joint of flagellum of antenna, VI.
Fig. 58. Antenna II., ... × 70
Fig. 59. Antennule I., ... ×150
Fig. 60. ,, IV., ... × 80
Fig. 61. Tip of endopodite of antenna, IV.
Fig. 62. Antennule, III., ... ×150
Fig. 63. ,, VI., ... × 80
Fig. 64. Antenna, IV., ... × 80
Fig. 65. Tip of endopodite of antennule, V.

PLATE III.

Fig. 66. Second maxilla, III., ... ×150
Fig. 67. ,, ,, VII., ... × 80
Fig. 68. First ,, I., ... ×150
Fig. 69. ,, ,, VII., ... ×150
Fig. 70. Second ,, VI., ... × 80
Fig. 71. ,, ,, IV., ... × 80
Fig. 72. Tip of endopodite of first maxillipede, II.
Fig. 73. Second maxilla, II., ... ×220
Fig. 74*a*. First maxilla, V., ... ×150
Fig. 74*b*. Second lobe of first maxilla, V.
Fig. 75. First maxilla, III., ... ×150
Fig. 76. ,, ,, II., ... ×150
Fig. 77. ,, ,, IV., ... ×150
Fig. 78. First maxillipede, I., ... ×150
Fig. 79. Hair on upper border of the lower lappet of first maxilla, I.
Fig. 80. Second maxilla, I., ... ×150
Fig. 81. Endopodite of second maxilla, V., ... ×150
Fig. 82. First maxilla, VI., ... ×150
Fig. 83. Bristle from basipodite of first maxillipede, I.
Fig. 84. Dentate thorn on middle lappet of first maxilla.
Fig. 85. First maxillipede, II., ... ×150
Fig. 86. ,, ,, III., ... ×150
Fig. 87. Second ,, VII., ... × 80
Fig. 88. ,, ,, I., ... × 70
Fig. 89. ,, ,, VI., ... × 80

Fig. 90. Dentate thorn from second maxillipede, VII.
Fig. 91. First maxillipede, VI., ... × 80
Fig. 92. Second ,, III., ... × 80
Fig. 93. Endopodite of second maxillipede, II., ... × 150
Fig. 94. Fourth and fifth joints of endopodite of second maxillipede, VI.
Fig. 95. First maxillipede, IV., ... × 140

PLATE IV.

Fig. 96. Dentate thorn from fifth joint of endopodite, second maxillipede, VI:
Fig. 97. Fourth and fifth joints of endopodite of second maxillipede, VII.
Fig. 98. First maxillipede, VII., ... × 80
Fig. 99. Fifth joint of endopodite of second maxillipede, VII.
Fig. 100. Endopodite of first maxillipede, V.
Fig. 101. Second maxillipede, IV., ... × 80
Fig. 102. Fifth joint of endopodite of second maxillipede, VI.
Fig. 103. Endopodite of second maxillipede, V.
Fig. 104. Third maxillipede, VI., ... × 80
Fig. 105. ,, ,, III., ... × 80
Fig. 106. ,, ,, VI., tip of exopodite.
Fig. 107. ,, ,, I., endopodite.
Fig. 108. ,, ,, V., ,,
Fig. 109. ,, ,, VI., uniserrated bristle.
Fig. 110. ,, ,, V., ... × 40
Fig. 111. ,, ,, IV., ... × 80
Fig. 112. ,, ,, VII., plumose bristle.
Fig. 113. ,, ,, VII., apex of cone of endopodite.
Fig. 114. ,, ,, VII., whorl round base of cone.
Fig. 115. ,, ,, VII., second and third joints of endopodite.
Fig. 116. ,, ,, VII., inner side of first joint of endopodite.
Fig. 117. ,, ,, VII., dentate thorn.
Fig. 118. ,, ,, I., ... × 150
Fig. 119. ,, ,, VII., dentate thorn, side view.
Fig. 120. ,, ,, VII., with many cilia on one side, two only on the other.
Fig. 121. ,, ,, II., ... × 70
Fig. 122. ,, ,, VI., dentate thorns.
Fig. 123. ,, ,, VI., whorls round base and on apex of cone.
Fig. 124. ,, ,, VII., ... × 120

PLATE V.

Fig. 125. First pereiopod, VI., carpopodite, and its articulations with the meropodite and propodite joints.
Fig. 126*a*. Pereiopods, I., from below, ... × 150
Fig. 126*b*. First pereiopod, I., side view, ... × 150
Fig. 127. Second ,, VII., ... × 40
Fig. 128. First ,, VI., basipodite and remains of exopodite.
Fig. 129. Second ,, VII., chela tip, ... × 230
Fig. 130. Hair from pereiopod, VII.
Fig. 131. Tip of fourth pereiopod, VI.
Fig. 132. Dactylopodite of first pereiopod, VI.
Fig. 133. Plain hair from pereiopod, VII.
Fig. 134. Second, third, fourth, and fifth pereiopods, VI., ... × 40
Fig. 135. Pereiopods, II., ... × 80
Fig. 136. Hair from pereiopod, VII.
Fig. 137*a*. & *b*. Pereiopods III., ... × 80
Fig. 138. First pereiopod, VI., ... × 40
Fig. 139. Pereiopods, V., ... × 40
Fig. 140. Knife-edge of propodite, first pereiopod, VI.
Fig. 141. Shears of first pereiopod, VII.
Fig. 142. Carpopodite, and its articulations with meropodite and propodite, VII.
Fig. 143. Second pereiopod, chela tip, VI.
Fig. 144. First pereiopod, VII., ... × 40
Fig. 145. Second, third, fourth, and fifth pereiopods, IV., ... × 80
Fig. 146. Third, fourth, and fifth pereiopods, VII., ... × 45
Fig. 147. First pereiopod, IV., ... × 80
Fig. 148. Tip of third pereiopod, VI.
Fig. 149. Shears of first pereiopod, VI., long dactylopodite, p. 110.
Fig. 150. Tip of fifth pereiopod, VI.
Fig. 151. Shears of first pereiopod, VI., short dactylopodite, p. 110.

H. C.

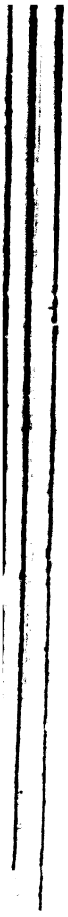


Fig. 152. Larva, I., side view, ... × 30
Fig. 153. Abdomen, VI., side view, ... × 30
Fig. 154. Ventral process of fourth abdominal segment, VII.
Fig. 155. ,, ,, fifth ,, ,,
Fig. 156. Abdomen, VII., side view, ... × 12
Fig. 157. Larva, II., ,, ... × 30
Fig. 158. ,, V., ,, ... × 12
Fig. 159. Moulted carapace, I., ... × 40
Fig. 160. Young shrimp, VI., ... × 12
Fig. 161. Inner border of fifth pleopod, VI.
Fig. 162. Third pleopod, VII., ... × 40
Fig. 163. Ventral process of first abdominal segment, VII.
Fig. 164. Fourth pleopod, VII., ... × 40
Fig. 165. Endopodite of first pleopod, VII.
Fig. 166. Second pleopod, VII., ... × 40
Fig. 167. Larva, III., ... × 30
Fig. 168. Third pleopod, VI., ... × 40

PLATE VI.

Fig. 169. Pleopod, IV.
Fig. 170. Larva, IV., ... × 12
Fig. 171. Second pleopod, VI., ... × 40
Fig. 172. First ,, VI., ... × 40
Fig. 173. Fifth ,, VI., ... × 80
Fig. 174. Endopodite of fifth pleopod, VII.
Fig. 175. Fifth pleopod, VII.. ... ... × 40
Fig. 176. First ,, V., ... × 80
Fig. 177. Endopodite of third pleopod, VII.
Fig. 178. ,, second ,, VII.
Fig. 179. ,, fourth ,, VII.
Fig. 180. Young shrimp, VII., ... × 12
Fig. 181. First pleopod, VII., ... × 40
Fig. 182. Endopodite of fifth pleopod, VII.
Fig. 183. Pleopod, III., ... × 40
Fig. 184. ,, I., ... × 40
Fig. 185. Fourth pleopod, VI., ... × 40
Fig. 186. Rostrum and eyes, VI., dorsal view, ... × 40
Fig. 187. Cephalic region, VI., ventral view.
Fig. 188. Rostrum, VI., side view, ... × 40
Fig. 189. Anterior portion of carapace, VII., dorsal, ... × 40
Fig. 190. Carapace, VII., side view, ... × 40
Fig. 191. Tip of dactylopodite of third pereiopod of adult shrimp, ventral view, ... × 80
Fig. 192. Thorax, VI., ventral view, ... × 40
Fig. 193. Tip of dactylopodite of fifth pereiopod of adult shrimp, seen obliquely from below, ... × 80
Fig. 194. Thorax, VII., ventral view, ... × 40
Fig. 195. Anterior region, VII., dorsal view, rostrum removed.
Fig. 196. Tip of dactylopodite of fifth pereiopod of adult, side view.
Fig. 197. Anterior cephalic region, II., ventral view.
Fig. 198. Labrum, labium, and mandible, I.
Fig. 199. Carapace, VI., dorsal view, ... × 40
Fig. 200. Plumose hair from hind lateral border of carapace, VI.

IV.—NOTES ON SOME PARASITES OF FISHES.

By Thomas Scott, F.L.S. (Plates VII.–VIII.)

CONTENTS.

	PAGE.
General Remarks,	120
Part I.—Copepoda Parasita,	121
Ergasilidæ,	121
Caligidæ,	124
Dichelestidæ,	126
Lernæidæ,	127
Chondracanthidæ,	128
Lernæopodidæ,	130
Incertæ Sedis,	136
Part II.—Hirudinea and Trematoda,	137
Hirudinea,	137
Ichthyobdellidæ,	137
Pontobdellinæ,	139
Trematoda,	141
Tristomatidæ,	142
Polystomatidæ,	145
Description of Plates,	151–153

GENERAL REMARKS.

In Part III. of the Eighteenth Annual Report of the Fishery Board for Scotland, I published some notes on the Parasites of Fishes that had been observed for the most part during the preceding year.

In that paper my observations were limited entirely to parasites belonging to the Crustacea. In the present paper I continue my observations on Crustacean parasites, but I also record a number of other forms belonging to the Hirudinea, or leeches, and the Trematoda. These, which form the subject of a separate section of this paper, have for the most part been observed on the skin and gills of fishes captured off the coast of Scotland by the "Garland"; some interesting forms have also been obtained on fishes received from the people in charge of the salmon fishings in the vicinity of the Fishery Board's Laboratory at Bay of Nigg.

But in addition to the study of the various creatures referred to above, my attention has also been directed, as opportunities occurred, to the study of the Entozoa of fishes. This has been done for the purpose of acquiring some knowledge of the more characteristic forms belonging to that group; and with reference to these organisms, it is almost superfluous to say that from their peculiar habits of life, and the remarkable transformations which many of them undergo, their study, though one of the most interesting, is also one of the most difficult that can engage the attention of the zoologist. These forms are still being studied, and I hope to be able to prepare some notes about them later on. Meantime I have to state that the records and observations which follow here are divided into two parts. The first part refers exclusively to Crustacean parasites belonging to the Copepoda; while the second part will include only such organisms as belong to the Hirudinea and the ecto-parasitic Trematoda.

It has been necessary, for the elucidation of some of the species recorded in both parts, to give drawings of several of them showing their characteristic forms as well as of some of their appendages; these drawings

have, as before, been done by my son, Mr. Andrew Scott, assisted by Mrs. Scott.

Mr. Peter Jamieson has also, as formerly, been of muc' ·sistance to me by the collection of specimens.

PART I.—COPEPODA PARASITA.

The Copepoda mentioned in the sequel include several species recorded in my former paper, but concerning which I am now able to give some additional information. A few are also recorded which have not previously been observed in Scottish waters.

Fam. ERGASILIDÆ.

Genus *Bomolochus*, Nordmann (1832).

Bomolochus soleæ, Claus.

1864. *Bomolochus soleæ*, Claus, Zeitschrift für Wissenschaft. Zool., vol. xiv., p. 374, Pl. XXXI.

In my previous note on this species I stated that it had been obtained on specimens of the common Sole, *Solea vulgaris*, captured in the Firths of Forth and Clyde as well as in the Humber near Grimsby. I have now to report the occurrence of what appears to be undoubtedly the same species in the nostrils of a number of different kinds of fishes, captured in the vicinity of Aberdeen and the Moray Firth. As many as twenty-nine specimens of this Copepod have been obtained in the nostrils of a single large cod caught in the Moray Firth by the "Garland," and sent to the Laboratory at the Bay of Nigg. The following is a list of the fishes in the nostrils of which the *Bomolochus* referred to has been obtained.*

Cyclopterus lumpus, L., the Lumpsucker, Bay of Nigg; Copepods not common in nostrils.

†*Gadus callarius*, L., the Cod, Moray Firth and vicinity of Aberdeen; Copepods frequent in nostrils.

Gadus æglefinus, L., the Haddock, Moray Firth; Copepods not common in nostrils.

Gadus merlangus, L., the Whiting, Moray Firth; Copepods not common in nostrils.

Gadus pollachius, L., the Pollack or Lythe, Bay of Nigg; Copepods frequent, but scarcely so much so as in the nostrils of the cod.

Pleuronectes platessa, L., the Plaice, Moray Firth; Copepods not common in nostrils.

Pleuronectes flesus, L., the Flounder, Bay of Nigg; Copepods not very rare in nostrils.

Solea vulgaris, Quen., the Common or Black Sole, Copepods found occasionally adhering to the skin.

The *Bomolochus* has been found much more frequently in the nostrils of the Cod than in those of any other fish which I have investigated; indeed there are few codfishes of moderate size which I examined that were not found to harbour *Bomolochus* in their nostrils. Frequently, not only

* See also *Ann. Scot. Nat. Hist.* (July, 1900), p. 153.

† My son, Mr. Andrew Scott, has found the same *Bomolochus* in the nostrils of codfish caught in Barrow Channel, near Barrow-in-Furness, Lancashire (*14th Ann. Rept L.M.B.C.*, Dec., 1900, p. 12).

adult males and females (the latter commonly with ovisacs) are observed, but also young ones in all stages of development, clearly indicating that the Copepodes are quite "at home" in this curious domicile. This habit on the part of *Bomolochus soleæ* is the more interesting when it is remembered that it is a "free living" species, and that there appears to be nothing to hinder it from leaving the nostrils of the fish, for it can move freely about amongst the mucus with which the nostrils are usually well supplied, and if the Copepods are removed and placed in clean sea water they may be seen swimming, or running about the sides of the vessel, with nearly as much agility as a "free-swimming" species. Judging from the number of adult and young specimens found in the nostrils of a single cod it is evident that the *Bomolochus* not only lives and propagates in this strange abode, but finds the conditions of life, amid such surroundings, fairly satisfactory, even though the accommodation be somewhat limited; one point in the Copepod's favour is that it has plenty of food, and is well sheltered from its enemies.

Quite recently, and after this paper had been sent to the printer, I obtained the heads of a number of Ling, *Molua molva* (L.), from the Fish Market at Aberdeen, and in the nostrils of several of them specimens of a *Bomolochus* not unlike those found in the nostrils of the fishes mentioned above, but somewhat larger, were observed. This adds another species to the list of fishes in the nostrils of which Copepods are found to live. I have, moreover, to record the occurrence of *Bomolochus* sp. on the gills of a Four-bearded Rockling, *Onos cimbrius* (L.), from the Firth of Forth, collected as far back as 1892, and also specimens of a *Bomolochus* sp., which were obtained on the back of a small *Zeugopterus punctatus* (Bl.), captured by the "Garland" near the mouth of the Clyde estuary in September 1897. At present I am unable to say whether all these *Bomolochus* belong to the one species or not, that will be determined later; meantime, it is interesting to observe how extensively *Bomolochus* is associated in one way or another with the fishes of our seas.

Genus *Thersites*, Pagenstecher (1860).

Thersites gasterosteus, Pagenstecher.

1861. *Thersites gasterosteus*, Pagenstecher, Arch. f. Naturg., vol xvii., p. 118, Pl. VI., figs. 1–9.

In my paper on the Parasites of Fishes published in the Eighteenth Annual Report, Part III., I stated that *Thersites gasterosteus* had been obtained on the inside of the gill-covers of *Gasterosteus aculeatus*, from Barra, Outer Hebrides, and in the Forth near Alloa; and that it had also been observed on *Gastræa* (*Gasterosteus*) *spinachia*, from Loch Etive. I have now to record its occurrence on *Gasterosteus aculeatus* captured in the brackish pools on the Aberdeen links, between the mouth of the River Don and the golf-course, on September 11th, 1900. *Thersites* appeared to be a comparatively common species here, as it was observed on nearly every one of the specimens of *Gasterosteus* captured. Both males and females were observed, and many of the latter were carrying ovisacs.

Genus *Ergasilus*, Nordmann (1832).

Ergasilus nanus, E. van Beneden. (Pl. VII., figs. 1–8.)

1870. *Ergasilus nanus*, P. J. v. Beneden, *Les Poissons des côtes de Belgique, leurs parasites et leurs commensaux*, p. 27, Pl. I., fig. 6 (recorded and figured but not described in this work).

Description of the female.—The body, which is elongated, is moderately stout anteriorly, but tapers gradually to the narrow posterior extremity. Its length from the broadly rounded forehead to the end of the caudal furca is 1·2 mm. (about $\frac{1}{21}$ of an inch). The cephalothoracic segment is large, and when seen from above is somewhat pear-shaped in its general outline; the widest part of the segment, which is equal to fully half its length, is about one-third of its length from the anterior end; while at about one-third of its length from the posterior end there is a distinct though not very deep contraction, which seems to indicate that an articulation has here become obsolete, and that this segment is really composed of two coalescent segments. The remaining thoracic segments are small, as shown by the full-sized drawing (fig. 1).

The antennules and antennæ.—The antennules are short, apparently only five-jointed, and moderately setiferous (fig. 2); the first joint is proportionally larger than any of the others; the proportional lengths of the joints are indicated approximately by the annexed formula :—

Numbers of the joints,	1 . 2 . 3 . 4 . 5
Proportional lengths of the joints,	26 . 12 . 10 . 9 . 11

The antennæ are large and strong, and are apparently used as powerful grasping organs; they are each three-jointed, and the second and third joints, which are elongated, are fully twice the length of the basal joint; each antenna is armed with a strong slightly curved terminal claw, nearly half as long as the joint to which it is articulated (fig 3).

Oral appendages.—The oral appendages in *Ergasilus nanus* are apparently more or less obsolete or rudimentary.

Thoracic feet.—The first four pairs of thoracic feet which are all well developed, are each of them two-branched; in the first three pairs the branches are each three-jointed, but in the fourth pair, while the inner branches, like the branches of the other three pairs. are three-jointed, the outer branches are only two-jointed (figs. 4-6). In the fifth pair, each foot consists of a single uniarticulate branch, subcylindrical in outline, and with the apex somewhat truncated and furnished with about three setæ (fig. 7).

The abdomen.—This portion of the animal is comparatively short, while the caudal furca are scarcely equal in length to the last abdominal segment. The specimen was provided with two large ovisacs of a light-bluish colour, and contained numerous ova (fig. 8).

Habitat.—Found adhering to the gills of a Thick-lipped Grey Mullet, *Mugil chelo*, Cuv., caught in the salmon-nets at Bay of Nigg, near Aberdeen, July 30th, 1900. It seems to be a rare species, for, though several mullets were examined, only one specimen of *Ergasilus* was observed.

Remarks.—One of the characters by which the *Ergasilus* may be readily distinguished from either *Bomolochus* or *Thersites*, is the great disproportion between the long and powerful antennæ and the short antennules, when compared with the same appendages in the other two genera named. This character is not peculiar to *Ergasilus nanus*, but appears to be common more or less to all the members of the genus. These long antennæ, armed as they are with strong terminal claws, enable the parasite to grasp securely the gill filaments of the fish to which it attaches itself. In *Thersites*, on the other hand, the antennæ, though moderately stout and armed with terminal claws, are short, even more so than the antennules. The *pear-like* form of the cephalothoracic segment does not appear to be peculiar to *Ergasilus nanus*, though it is perhaps more obvious in that species; but it is interesting to note that the drawing of the parasite given by Prof. P. J. v. Beneden in his work on

the fishes of the coast of Belgium, shows the cephalothoracic segment to have practically the same outline as that represented here.

Ergasilus sieboldii, Nordmann, found on the Pike, *Esox lucius*, and one or two other fresh-water fishes is, as figured by Prof. C. Claus,* somewhat similar to *Ergasilus nanus* in its general outline, and in one or two details of structure; it will be observed, however, that in the original description of this Copepod by Nordmann,† the cephalothorax is more rotund, the abdomen is proportionally rather shorter and more distinctly differentiated from the thorax, and the six-jointed antennules are shown to be rather more elongated and slender.

Distribution.—Found on *Mugil chelo*, Cuv., caught at Ostend and on the coast of Brittany (P. J. v. Ben., *Poiss. d. côtes d. Belg.*, p. 27). On *Mugil chelo*, Cuv., caught "dans les environs de Saint-Vaast, Côtes de La Manche" (A. E. Malard, *Bull. Soc. Philom. de Paris* (8), t. ii., No. 2, p. 30—separate reprint). On *Mugil chelo*, Cuv., caught in the Gulf of Trieste (Ed. Graeffe, *Arbeit. d. Zool. Inst. z. Wien*, t. xiii.,—Heft 1, p. 41, 1900).

Fam. Caligidæ.

Genus *Caligus*, Müller (1785).

Only one species belonging to the genus *Caligus* falls to be noticed at this time, viz.:—

Caligus scombri, Basset-Smith. (Pl. VII., figs. 9, 10.)

1898. *Caligus scombri*, Basset-Smith, Ann. and Mag. Nat. Hist., (7) vol. ii., p. 83., Pl. 14., fig. 2.

A single specimen of a *Caligus*, apparently belonging to this species, was found adhering to the inside of one of the gill-covers of a Mackerel, *Scomber scombrus*, Lin., caught in the vicinity of Aberdeen, August 17th, 1900. The specimen was a female, no male was obtained.

It will be observed from the drawing of this specimen (fig. 9) that the cephalic segment does not greatly exceed the thorax in length, and that the abdomen is nearly as long as the cephalic shield; the body is thus divided into three nearly equal portions.

The *sternal fork* (fig. 10) resembles that of *Lepeophtheirus thompsoni*, Baird, while the fourth pair of feet are somewhat like those of *Caligus diaphanus*, Nordm. In general appearance *Caligus scombri* is not very unlike *Lepeophtheirus thompsoni*, and, but for the fact that it possesses frontal *lunulæ*, might be mistaken for that species.

There does not appear to be any previous record of this *Caligus* for Scotland. It is a comparatively small species; the specimen represented by the drawing measures scarcely 5·5 mm. in length, from the forehead to the end of the caudal furca.

Genus *Dinematura*, Latreille (1827).

Dinematura producta (O. F. Müller).

1785. *Caligus productus*, O. F. Müller, Entomostraca, p. 132, Pl. XXI., fig. 3.

The examples of *Dinematura producta*, recorded in my paper published

* Prof. C. Claus, Parasitische Copepoden (Zeitschrift fur wiss. Zool., Bd. xxv., 4), separate copy. p. 15, Pl. XXIII., fig. 12 (1875).

† Prof. A. Nordmann, Mikrogr. Beiträge z. Naturg. d. Wirbel. Thiere, Zweites Heft, p. 15, Taf. II. (1832).

last year, were obtained from one or two young specimens of Porbeagle Sharks landed at Aberdeen Fish Market, but the localities where these sharks had been captured could not be given with certainty. In the present paper I am able to record *Dinematura producta* from sharks captured at two different places close to the shores of Scotland. On November 16th, 1900, a Porbeagle Shark was caught off Dunrobin Castle, on the north side of the Moray Firth, during some investigations that were being carried on there on behalf of the Fishery Board; several fine specimens of the *Dinematura* were obtained on this shark. These specimens, which are finer and more perfect than those from which the drawings for my previous papers were prepared, are now in the collection at the Laboratory at Bay of Nigg. But besides these specimens from the Moray Firth, I have, through the kindness of Prof. D'Arcy W. Thompson, Dundee, had the privilege of examining a few fine examples of the same parasite taken from a Thrasher Shark, *Alopias vulpes* (Gmel.), captured near Buddon, Firth of Tay, on July 30th, 1889; these specimens are in the Museum of University College, Dundee; they are specially interesting from having been obtained on a Thrasher Shark; the shark they are most frequently found upon appears to be the Porbeagle.

The specimens recorded by Dr. Baird (Brit. Entom., p. 286) were obtained by Dr. Johnston from a Porbeagle Shark captured in Berwick Bay in September 1834.

Dinematura serrata, Kröyer.

1863. *Dinemoura serrata*, Kr., Bidrag til Kundskab om Snyltekrebsene (1863), p. 176, Pl. VIII., fig. 4.

Habitat.—Taken on a Short Sunfish, *Orthagoriscus mola* (L.), at Banff in 1862 by the late Thomas Edward.

The Rev. A. M. Norman informs me that he has specimens of this species in his collection sent to him by Mr. Edward. The species when discovered by Edward was new to science, and the Rev. A. M. Norman, in his M.S. notes, gave it the name of *Monim fimbriata*. Unfortunately no description of the parasite was published till Kröyer did so in 1863 under the name which it now bears. The species will be found recorded under Dr. Norman's M.S. name *Monima fimbriata*, in the Appendix to Samuel Smiles's Life of Thomas Edward, p. 437 (1877), as one of the many creatures which that keen-sighted naturalist added to the fauna of Scotland.

Genus *Echthrogaleus*, Steenstrup and Lütken (1861).

Echthrogaleus coleoptratus (Guérin).

1817. *Dinematura coleoptrata*, Guérin, Icon. d. règne animal, vol. iii., Pl. XXXV., fig. 6.

A specimen of this somewhat rare species was taken from the fin of a Dogfish, caught to the east of Fair Island (between Orkney and Shetland), on October 18th, 1900. The species to which the fish belonged is somewhat uncertain, as the fish was not preserved and no note of it was taken at the time it was captured, but probably it was a young Porbeagle Shark, *Lamna cornubica*. The specimens of *Echthrogaleus* recorded in my previous paper were taken from the fins of a Porbeagle Shark landed at the Fish Market at Aberdeen; and according to Dr. Baird (Brit. Entom., p. 285), the same species of *Echthrogaleus* was obtained by the late Dr. Johnston, Berwick-on-Tweed, also from a Porbeagle Shark, captured in

Berwick Bay in 1834. Dr. Basset-Smith also gives *Lamna cornubica* as the host of the *Echthrogaleus*. It would appear from Dr. Johnston's remarks on the habits of this parasite that his specimens were not obtained on the fins, but were found adhering to the "sides of the branchial covers" of the Porbeagle; and he also adds that it "appears to be parasitical on several species of fish." He does not, however, give the names of any other species of fish on which *Echthrogaleus* was found, nor the name of anyone who had found this parasite on other fishes.

Genus *Cecrops*, Leach (1816).

Cecrops latreillii, Leach.

1816. *Cecrops latreillii*, Leach, Ency. Brit. Suppl., vol. i., p. 20, figs. 1–5.

A large number of specimens of *Cecrops* were obtained on the gills of a Short Sunfish sent from Mallaig, West Coast of Scotland, to the Laboratory at Bay of Nigg in April, 1900; the specimens comprised both males and females.

A correspondent (William Evans, Edinburgh) has kindly forwarded to me the following interesting extract from the M.S. minutes of a meeting of the Royal Physical Society held in Edinburgh on January 15th, 1851:—"Specimens of *Cecrops latreille*, a singular parasitic animal, were exhibited by John Stewart, Esq., taken from the gills of a Short Sunfish captured in Glenluce Bay." This bay is part of Solway Firth district.

Fam. Dichelestidæ.

Genus *Clavella*, Oken (1815).

Clavella hippoglossi, Kröyer. (Pl. VII., fig. 11.)

1838. *Clavella hippoglossi*, Kr., Naturh. Tidsskrift, R. i., vol. i., p. 196, Pl. II., fig. 3.

In my paper in Part III. of the Eighteenth Annual Report I gave a short description and some figures of the female of this species, and added that no males had been observed. In the present paper I am able to record the discovery of a single male specimen of *Clavella hippoglossi*, which occurred amongst a considerable number of females taken from a Halibut in the Fish Market at Aberdeen during the past summer.

This male, which is represented by the drawing on Plate VII. (fig. 11), measures only about 1·5 mm. (about $\frac{1}{17}$ of an inch) in length. The antennules, like those of the female, are five-jointed. The antennæ resemble those of the female, but are much more strongly hooked. The head is proportionally larger, the thorax more distinctly segmented, and the genital segment considerably shorter than in the female. The abdominal appendages are more prominent and elongated, as shown by the drawing.

The males of *Clavella hippoglossi* are apparently very rare; the one now recorded is the only one I have seen, though many specimens of females have been examined, and I do not find any records of males in any of the works on fish parasites to which I have access. Perhaps one of the reasons why the males have escaped notice hitherto may be because they are so small, but, whatever the reason, it is evident that males are not so common in proportion to the females as they are found to be in some other species, *e.g.*, in *Chondracanthus* and *Brachiella*.

Clavella labracis, van Beneden.

1870. *Clavella labracis*, v. Ben., Les Poiss. d. côtes d. Belg., pp. 45–46, Pl. I, fig. 4. (The species, though recorded and figured, is not described in this work.)

A number of specimens of this *Clavella* were obtained on the gills of specimens of the Striped Wrasse, *Labrus mixtus*, captured in the Clyde near Ayr, January 30th, 1900. The species is a small one, ova-bearing specimens being scarcely a millemetre in length, but though the copepod itself is small, it carries comparatively large eggs; these, however, are few in number, and are arranged in a single series. Prof. v. Beneden has found *Clavella labracis* "in abundance" on the gills of *Labrus maculatus*, Bloch (*L. berggylta* Asc.); he also records it from the gills of *Labrus trimaculatus*, Gmel. (*L. mixtus*, L.—the same species of fish as that on which I also found the *Clavella*). *C. labracis* appears to be an addition to our fauna.

Genus *Cycnus*, M.-Edwards (1840).

Cycnus pallidus (P. J. van Beneden).

1854. *Congericola pallida*, P. J. van Ben., Acad. Roy. Belg., t. xxi., pt. 2, p. 583.

This parasite is found on the gills of the Conger Eel, *Conger niger* (Risso), (*C. vulgaris*, Cuv.), and is recorded in my former paper as having been taken from the gills of a conger captured in the Firth of Clyde. I have now to record the occurrence of the same parasite on the gills of one or two Conger Eels captured in the salmon-nets at the Bay of Nigg in July and August 1900. A few *Cycnus* were obtained on the gills of a conger caught on the 21st July, on another caught on the 23rd, and also on one caught on the 25th. Several other specimens were taken from the gills of a conger captured by the salmon fishermen on August 4th, while on one caught on August 16th no fewer than twenty *Cycnus* were observed. All these examples of conger were of moderate size; two of those captured in July measured fully four feet in length, while the one caught on August 16th was over four feet nine inches long. As all the large congers examined hitherto have been found to harbour *Cycnus* in fewer or larger numbers, it would seem that the parasite is not at all a rare form. Of course, its occurrence in any quantity may be limited to certain areas; but that it has a wide distribution is apparent from the fact that it has been on obtained on the gills of conger at Plymouth by Dr. Basset-Smith, and by my son, Mr. Andrew Scott, at Piel, Barrow-in-Furness. It has also been recorded by P. J. v. Beneden from the gills of conger captured on the coast of Belgium,* and by Dr. Graeffe from the same species, taken in the Gulf of Trieste, in the Adriatic.

Fam. LERNÆIDÆ.

Genus *Lernæenicus*, Lesueur.

Lernæenicus sprattæ (Sowerby).

1806. *Lernæa sprattæ*, Sow., British Miscellany, ii., p. 17, Pl. LXVIII.

In my previous paper on Fish Parasites I recorded this species as having

* This author does not appear to have found the parasite very common, for he says—"Il n'est pas abondant: on en trouve rarement une demi-douzaine dans le même poisson" (Les Poiss. d. côtes d. Belg., p. 82, footnote).

been observed on the eye of a Clupeoid at Leith, Firth of Forth, and I have now to record its occurrence on the eyes of sprats captured in the Solway Firth near Annan. One of the specimens of *Lernæenicus* was observed on the eye of a sprat captured on the 24th of May, and two on sprats captured on November 27th, 1900. The specimens were observed by Dr. Fulton, our Superintendent, who kindly handed them over to me. This is the first time *Lernæenicus sprattæ* has been recorded for the West of Scotland.

Genus *Lernæa*, Linné (1767).

Lernæa minuta, T. Scott.

1900. *Lernæa minuta*, T. Scott, Eighteenth Annual Report of the Fishery Board for Scotland, Pt. III., p. 161, Pl. VII., fig. 13.

This small *Lernæa* was described and figured in Part III. of the Eighteenth Annual Report of the Fishery Board for Scotland, from specimens obtained on *Gobius minutus* sent to the Laboratory from Annan (Solway Firth). Several additional specimens of this *Lernæa* have been obtained on examples of the same species of Goby captured at Annan on October 31st, 1900, and forwarded to the Laboratory. Annan is still the only locality where this species has been obtained. No males have yet been observed.

Lernæa lumpi, T. Scott. (n. sp.) (Pl. VII., fig 12.)

The somewhat curious parasite which I record here under the name of *Lernæa lumpi* was obtained on the gills of a moderately large adult female Lumpsucker, *Cyclopterus lumpus*, Lin., captured in the salmon-nets at the Bay of Nigg, near Aberdeen, March 29th, 1900.

The parasite is about two inches in length (50 mm.). It is moderately slender, and a portion of the posterior end is bent round so as to assume a hook-like form,—this part of the body is not sigmoid as in *Lernæa branchialis*. The cephalic appendages are not so greatly developed as in that species; the neck is long and slender and gradually merges into the somewhat stouter posterior part of the body. There is a distinct constriction between the genital segment where the ovisacs are attached and the caudal portion of the body, and as I have, so far, only seen one specimen of the parasite, I am unable to say whether the constriction is normal or accidental. The ovisacs are small, and, as is usual in *Lernæa*, they are also more or less twisted.

The head, and a portion of the neck measuring about three-quarters of an inch, were buried amongst the tissues of one of the gill-arches of the *Cyclopterus*.

Only the one specimen of the *Lernæa* was observed, notwithstanding that nearly two hundred Lumpsuckers were examined; it would appear from this to be a moderately rare species. *Lernæa lumpi* is the largest member of the genus I have yet observed.

Fam. CHONDRACANTHIDÆ.

Genus *Sphyrion*, Cuvier (1830).

Sphyrion lumpi (Kröyer). (Pl. VII., fig. 13.)

1845. *Lestes lumpi*, Kr., Danmarks Fiske, vol. ii., p. 217.
1863. *Lesteira lumpi*, Kr., Bidrag til Kundskab om Snylte-krebsene, p. 325, Pl. XVIII., fig. 5.
1899. *Sphyrion lumpi*, Basset-Smith, Proc. Zool. Soc. (April 1899), p. 489.

A damaged specimen of this curious species was obtained on a Lump-sucker, *Cyclopterus lumpus*, L., captured in the salmon-nets at Bay of Nigg on April 23rd, 1900. When observed, the specimen was minus the head, owing probably to the fish having been roughly handled. The specimen also appeared to be somewhat immature, but there can be no doubt as to its identity with the species to which it is ascribed. The drawing on Plate II. gives a fairly accurate representation of the specimen, which measures 13.2 mm. or fully half an inch in length, exclusive of the caudal appendages.

Sphyrion lumpi seems to be a rare species; the only British locality where it is said to have been found is Dungeness, and even that is doubtful; while on the Continent it does not appear to have been observed anywhere but in Denmark. The Rev. T. R. R. Stebbing records a closely allied species (*Sphyrion lævigatum*, Guérin-Méneville), from Mossel Bay, Cape of Good Hope, taken from the abdomen of a "Ling," *Genypterus blacodes* (*Report of the Marine Biologist* (1898), published by the Department of Agriculture, 1899, p. 198); and G. M. Thomson records the same parasite (also from *Genypterus blacodes*) from New Zealand (Trans. N.Z. Inst., vol. xxii. (1889), p. 370, Pl. XXVIII., fig. 4).

Genus *Chondracanthus*, De la Roche (1811).

Chondracanthus ornatus, T. Scott. (Pl. VII., fig. 14.)

1900. *Chondracanthus ornatus*, T. Scott, Eighteenth Annual Report of the Fishery Board for Scotland, Part III., p. 168.

This species, which was described in Part III. of the Annual Report referred to, was obtained on the gills of Spotted Dragonets, *Callionymus maculatus* Raf., captured in the Firth of Clyde and the Moray Firth. I have now to record the occurrence of the same *Chondracanthus* from the gills of a *Callionymus* captured about 50 miles to the east of Fair Island (between Orkney and Shetland), on the 19th October, 1900. This record extends the distribution of *C. ornatus* very considerably.

When preparing a description of the species for my previous paper, want of time prevented me from adding any drawings to illustrate its form or structure, and I take this opportunity to present a full-sized figure of the species prepared from a fairly typical specimen; this figure shows the animal as seen from above. In the description of the species the following statement occurs:—"This Copepod viewed from above has a general outline closely similar to that of an equilateral triangle, the bluntly rounded head forming the apex and the truncate posterior end the base. The front of the head is indistinctly trilobed, one lobe being in the centre and projecting slightly in front of the two lateral lobes, which, like the central one, are bluntly rounded. The neck connecting the head with the thorax is very short. Along each side of the thorax (forming the sides of the triangle) there are three or four more or less distinct tubercles, and a series of three similar tubercles extends along the middle of the dorsum. The posterior tubercle of the middle series stands well up, but each of the other two stands at a slightly lower elevation than the one immediately behind. The abdomen is exceedingly small and inconspicuous. The ovisacs are of moderate length and stoutness, like those of *Chondracanthus limandæ*." The arrangement and position of the lateral tubercles seem to vary slightly in different specimens. No males have yet been observed.

Though *C. ornatus* is of comparatively moderate size, being about 5 mm. in length, and as much in width at the posterior end, it is so well concealed by the gill-covers that it easily escapes notice, and it is only by turning back the gill-covers that one can make sure whether the *Chondracanthus* is present or not.

Fam. LERNÆOPODIDÆ.

Genus *Charopinus*, Kröyer (1863).

Charopinus dalmanni (Retzius). (Pl. VII., fig. 16.)

1831. *Lernæa dalmannii*, Retzius, Froriep's Notizen, xxix., p. 617, Pl. VI., fig. 5.

1863. *Charopinus dalmannii*, Kr. Bidr. til Kundsk. om Snyltekr., p. 280, Pl. XIV., fig. 6.

This species was obtained in the nasal fossæ of a Grey Skate, *Raia batis*, captured in the Moray Firth, November 16th, 1900. This, I think, is a new station for the species in Scotland. The drawing (fig. 16) shows a side view of the modified extremities of the second maxillipedes, by means of which it is anchored securely to its host. The form which this modification assumes becomes one of the chief characters for distinguishing this species of *Charopinus* from the others. The importance of this character is also referred to in the description of the next species—*C. ramosus*, Kröyer.

Charopinus ramosus, Kröyer. (Pl. VII., figs. 17–23.)

1863. *Charopinus ramosus*, Kr., Naturh. Tidsskr., R. iii., p. 284, Pl. XIV., figs. 5, a–i.

Charopinus ramosus, Kr., is a comparatively small species; the specimen represented by the drawing (fig. 17) measures from the forehead to the extremity of the posterior appendages only nine millimeters, whereas *C. dubius* is about twice, and *C. dalmanni* four times that length. The most important and characteristic difference, however, is in the form assumed by the extremities of the second maxillipedes. These appendages are united near their distal ends by their inner surfaces, but instead of forming at their junction a chitonous plate like *C. dubius*, each maxilliped terminates in a lateral biramose process which penetrates the tissues of the host.

In the few specimens of *Charopinus ramosus* I have seen, the terminal rami of the second maxillipedes are more divaricate than they are shown to be in Kröyer's figure, but this difference, which seems to be unimportant, may be due to the position in which the parasites were attached to the fish.

Charopinus ramosus was obtained on the gills and gill-arches, both of *Raia clavata* and *Raia maculata* landed at the Fish Market at Aberdeen on June 27th, 1900, but it appeared to be somewhat rare.

Charopinus dubius (T. Scott). (Pl. VII., fig. 15.)

1900. *Charopinus dubius*, T. Scott, Eighteenth Annual Report of the Fishery Board for Scotland, Pt. III., p. 170.

A few more specimens of *Charopinus dubius* have been obtained on the gills and gill-arches of some specimens of *Raia circularis* landed during the past year at the Fish Market at Aberdeen.

This species is intermediate in size between *Charopinus dalmanni* and

Ch. ramosus, and like the latter it has only hitherto been obtained attached to the gills or gill-arches of its host and not in the nasal fossæ. It appears to be a more common species than *Ch. ramosus*, being found with moderate frequency on the specimens of *Raia circularis* which have so far been examined. The most distinctive specific character of *Ch. dubius*, as stated in the description of the species published in my former paper on the Parasites of Fishes, is the form assumed by the extremities of the second maxillipedes, which are modified so as to enable the parasite to anchor itself to the fish. In this species the maxillipedes unite at their extremities and form a single horny or chitonous enlargement, which differs in form from that of the same appendages in *Ch. dalmanni* and *Ch. ramosus*.

In my previous paper on Fish Parasites, it was pointed out that, according to Kröyer, the more important characters by which *Charopinus dalmanni* (Retz.) and *Ch. ramosus* are distinguished are taken chiefly from the form assumed by the apices of the second maxillipedes, and therefore in the present paper I give figures of the apical portions of the second maxillipedes of all the three species mentioned in the foregoing notes; these figures are placed in juxtaposition that they may show more clearly the differences that exist between these three *Charopini*.

In *Charopinus dalmanni* the apices of the second maxillipedes, though placed closely side by side, as shown in Plate VIII., fig. 6, of my previous paper,* are not adherent to each other, and if they be viewed from the side they are seen to have each a semilunate form (see fig. 17, Pl. VII. of the present paper), they are thus enabled to grasp a portion of the tissue into which they have been inserted, and which has in some way through contact with them become modified and hardened, and as the apices themselves have become considerably enlarged they are able to obtain a firm and secure hold of that part of the host to which the parasite has in this way attached itself. In *Charopinus ramosus*, on the other hand, the second maxillipedes, as already stated, become coalescent near the distal end and there send out on each side a moderately large biramose appendage, the rami of which, though in some cases as figured by Kröyer, not much separated, are in other examples considerably divergent (fig. 17, Pl. VII.). In *Charopinus dubius* the second maxillipedes become coalescent at the apex and develop a moderately large horizontal appendage, which is of a brownish colour and a hard structure; when perfect, this appendage is in general appearance somewhat boat-shaped, and having the ends slightly turned up (fig. 15, Pl. VII.). On the under side of the appendage there is what appears to be a disk, of an oval, or in some cases of a nearly circular form, probably caused by a fold of the under surface, and it sometimes happens that, if one is not very careful in dissecting out an appendage from the tissues in which it is embedded, the ends of it may get broken off and only the disk-like central portion is left. The second maxillipedes of the specimen from which the species was described appear to have been injured in the way I have indicated, and hence the remark that "The second maxillipedes . . . are joined to each other at the apex by small horn-coloured plugs which unite to form a thin circular horny disk, hollow in the middle, with the margins slightly reflexed."† If the differences in the form of the anchoring arrangement assumed by the second maxillipedes of *Charopinus*, such as have been described, be more or less of a permanent character, and there seems to be little doubt that they are so, the three species mentioned here must be held as sufficiently distinct, the one from the other.

**Eighteenth Annual Report*, Part III. (1900).

†*Op. cit.*, Part III., p. 170.

Genus *Actheres*, Nordmann (1832).

Actheres percarum (Nordmann).

1832. *Actheres percarum*, Nordm., Mikrog. Beiträge, p. 63, Pl. I.

Habitat.—On the gills of the common Trout, Moray district (T. Edward, Banff). Nordmann records this species as found on the gills of the common Perch, *Perca fluviatilis*, L., and the Pike-Perch, *Stizostethium lucioperca* (L.).

The Rev. A. M. Norman informs me that this species of Copepod was sent to him by Thomas Edward, who obtained it somewhere in the neighbourhood of Banff, and that it is now in his collection. *Actheres percarum* is recorded in the Appendix to Samuel Smiles's Life of Edward (p. 437) as *Basanistes salmonea*. It appears that Edward obtained the *Actheres* on the gills of Salmon as well as on the gills of the common Trout.

Genus *Lernæopoda*, Kröyer (1837).

Lernæopoda elongata (Grant).

1827. *Lernæa elongata*, Grant, Brewster's Edin. Journ. Sci., vol. vii., p. 147, Pl. II., fig. 5.

A specimen of this Lernæopod was taken by Mr. Dannevig from the eye of a Shark caught to the eastward of Fair Island (between Orkney and Shetland) by the steam trawler "St. Andrew," October 19th, 1900. This specimen, which is now in the collection in the Fishery Board's Laboratory at Bay of Nigg, gives the following measurements:—Length of body, exclusive of the second maxillipedes, fully 15 mm. ($\frac{3}{5}$ inch). Length of the second maxillipedes, fully 15 mm. (or as long as the body).

The species of the shark from the eye of which Mr. Dannevig removed the Copepod was not definitely ascertained, but it was probably a Porbeagle shark, *Lamna cornubica*.

Mr. Ingram, the Fishery Officer at Aberdeen, brought me recently another specimen which he had removed from the eye of a shark about six feet in length—which, from his description, appeared to be a Greenland shark,—landed at the Aberdeen Fish Market. This specimen measured about 40 mm. ($1\frac{3}{5}$ inches) from the extremity of the second maxillipedes to the posterior end of the body.

The specimen recorded in my previous paper* was taken from the eye of a Porbeagle Shark, but the locality was not clearly ascertained. The only British specimen which Dr. Baird records† was taken by Mr. Yarrel from the eye of a shark caught on the English coast and brought to London in the winter of 1848, but the species to which this shark belonged is not stated.

Genus *Brachiella*, Cuvier.

Brachiella bispinosa, Nordmann.

1832. *Brachiella bispinosa*, Nordm., Mikrog. Beiträge, p. 94, Pl. VIII., fig. 4.

Habitat.—On the gills of *Trigla sp.*, Moray Firth, 1863 (T. Edward).

**Eighteenth Annual Report*, Pt. III., p. 171, Pl. VIII., figs. 11-15 (1900).
†Brit. Entom., p. 333, Pl. XXXV., fig. 5 (1850).

The Rev. A. M. Norman has kindly directed my attention to the fact that this Copepod was obtained by the late Thomas Edward of Banff on the gills of Gurnards caught in the Moray Firth, and specimens sent to him by Edward are in his collection. The species is recorded in the Appendix to Samuel Smiles's life of the Banff naturalist (p. 438), 1877. This is the only Scottish record of *Brachiella bispinosa* known to me.

Brachiella (?) *triglæ*, Claus. (Pl. VII., figs. 24–29.)

1860. *Brachiella triglæ*, Claus, Zur Morph. der Copep., Pl. I., fig. 6.

1896. *Brachiella triglæ*, Basset-Smith, Journ. M.B. Assoc., Plymouth, p. 163.

A few specimens of a Copepod apparently belonging to this species were obtained on the gills of a specimen of *Trigla lineata*, Gmel., captured in the Clyde in the vicinity of Ailsa Craig in 1897, but only now recorded.

The species is a small one; the specimen figured measures only 4·5 mm. (about $\frac{2}{11}$ of an inch), but is comparatively moderately stout; the head and neck are scarcely so elongated as the posterior thoracic part of the body; the second maxillipedes, which are very short, appear to be free except at the point of attachment to the gills of the fish. The genital segment is considerably dilated and somewhat irregular in outline, and emarginate in the posterior end; the abdomen is very rudimentary; and the two posterior appendages do not extend much beyond the general contour of the body (fig. 24).

The antennules are short and apparently four-jointed, the end joints being slender (fig. 25). The antennæ are moderately stout, and somewhat like those of *Lernœopoda galei* (fig. 26), while the mandibles, maxillæ, and first maxillipedes are more or less similar to the same appendages in *Thysanote impudica*, Nordm. (figs. 27–29).

Brachiella triglæ, Claus, appears to be extensively distribnted; it has been obtained at Plymouth, by Dr. Basset-Smith from "*Trigla cuculus*, *gurnardus*, and *hirundo*, but was not very common."* Dr. Claus (*op. cit.*) and Dr. W. Kurz† have also recorded the occurrence of this Copepod on the gills of *Trigla;* Dr. Ed. Graeffe gives *Anchorella triglæ*, Kurz (*Brachiella triglæ*, Cls.) in his *Uebersicht der Fauna der Golfes von Triest*,‡ and states that, according to Kurz, it has been found living attached to the gill-arches of *Trigla lineata*—the same species of Gurnard on which I also obtained it.

Brachiella ovalis (Kröyer). (Pl. VII., figs. 30–35.)

1837. *Anchorella ovalis*, Kr., Naturh. Tidsskr., R. i., p. 289, Pl. III., fig. 6.

1870. *Anchorella ovalis*, P. J. v. Ben., Poiss. d. côtes de Belg., p. 31, Pl. II., fig. 8.

Brachiella ovalis has the cephalothorax rather more elongated than the genital segment. The second maxillipedes are short and separated from each other except at the extremity where they are attached to the gill-raker. The genital segment is considerably dilated; the posterior end of this segment has the sides moderately straight, and, converging slightly

* *Journ. M.B. Assoc., Plymouth* (Feb. 1896), p. 163.

† *Zeitsch. f. Wiss. Zool.* (1877), p. 404, Pl. XXV., figs. 13–15.

‡ *Arbeiten der Zoolog. Institute zu Wien*, T. XIII., Heft I. (1900).

backwards, they form an obtuse angle at the point where they meet; the abdomen is very rudimentary; there are two small posterior appendages—one on each side of the abdomen—but they are so much obscured by the short but considerably dilated ovisacs as to be easily overlooked; this is probably the reason they are not shown in the figure of the species in Prof. v. Beneden's work referred to above. *Brachiella ovalis* is very small; the specimen represented in the drawing (fig. 30) measures little more than 2 mm. in length.

In this species the antennules appear to be four-jointed, the first joint is much dilated, but the others are small; the third joint is very short, being scarcely half the length of the end joint (fig. 31); the antennules of *Brachiella ovalis* resemble somewhat those of *Lernæopoda galei*; the antennæ have also a close resemblance to those of that species (fig. 32). The mandibles are moderately stout, and are furnished with a series of small irregular teeth at the distal end of the inner margin (fig. 33); while the maxillæ are somewhat like those of *Anchorella emarginata*, Kr. (fig. 34). The first maxillipedes are moderately stout, the terminal joint, which is hinged to the second one, is armed with a short but moderately strong claw (fig. 35).

Habitat.—Found attached to the gill-rakers of the common Gurnard, *Trigla gurnardus*, caught in the Moray Firth and forwarded to the Fishery Board's Laboratory at Bay of Nigg, from the "Garland," during April and May, 1900. The parasites were more frequently seen on the gills of half-grown specimens of the fish than on the adults. Both Kröyer and P. J. v. Beneden record *Brachiella* (or *Anchorella*) *ovalis* from the common Gurnard.

There cannot, I think, be any doubt that the species recorded above is the "*Anchorella ovalis*" of Kröyer as figured by P. J. v. Beneden in his work on the fishes of the coasts of Belgium (Pl. II., fig. 8). The only apparent discrepancy between his figure and the above description is that he does not show any appendages on the posterior end of the genital segment, but these appendages are so small that they may have been concealed by the dilated ovisacs; sometimes it is almost impossible to see these appendages till the ovisacs are removed.

In this species the arms (second maxillipedes), though short, are distinctly separate along their whole length, and their structure shows a closer affinity with *Brachiella* than with *Anchorella*; I have therefore ascribed it to that genus. I have, so far, seen no males of this species, and till these are described the question as to the genus to which the species really belongs may remain a doubtful one.

Genus *Anchorella*, Cuvier (1817).

Anchorella stellata, Kröyer. (Pl. VIII., figs. 1-2.)

1838-39. *Anchorella stellata*, Kr., Naturh. Tidsskr, R. i., vol. ii., p. 142, Pl. III., fig. 5.

1900. *Anchorella stellata*, T. Scott, Eighteenth Ann. Rept. of the Fishery Board for Scotland, Pt. III., p. 178.

In Part III. of the Eighteenth Annual Report, I gave a moderately full description of *Anchorella stellata*, Kr., but want of time prevented me from illustrating the description with drawings of the more important characters referred to, and I therefore take this opportunity to submit one or two figures showing the more characteristic points by which the species is distinguished. Figure 1 gives a side view of an *Anchorella stellata* attached to a scale of the Hake, *Merlucius merluccius* (L.), by a

chitinous plug which penetrates the substance of the scale. Figure 2 represents a front view of the plug after removal from the scale in which it was embedded. This plug, after penetrating the scale of the fish, expands between its outer and inner surfaces into a thin roundish disk; the parasite thus obtains a secure hold and can only be detached by the falling off or removal of the scale to which it has fixed itself, or by the attachment being severed at the point where it penetrates the scale. An interesting feature of the disk is that it possesses a number of openings (or pellucid markings) just inside its circumference, which have a regular stellate arrangement as shown by the figure, and from which the name of the species is derived. How these markings are produced, or what purpose they serve, are questions that may not be easy to explain, but the solution would no doubt be interesting.

The species has been found parasitic on Hake captured in the Clyde by the "Garland," but does not appear to be very common.

Anchorella scombri, Kurz. (Pl. VIII., fig. 3.)

1877. *Anchorella scombri*, Kurz, Zeitschrift f. wissenschaftl. Zool., B. xxix., p. 403, Pl. XXV., fig. 12.

This curious species was found on the gills of a Mackerel, *Scomber scombrus*, Lin., captured in the vicinity of Aberdeen, August 17th, 1900.

In this *Anchorella* the thorax is extremely elongated and moderately stout; the genital segment is nearly globular and small in comparison to the thorax. The second maxillipedes are very short, and appear to be entirely coalescent. The abdomen is rudimentary or obsolete, and the genital segment is apparently unprovided with posterior appendages. The ovisacs of the specimen represented by the drawing, and which is the only one I have yet seen, are small (fig. 3).

This species has at first sight a somewhat close resemblance to *Anchorella emarginata*, Kr., but a closer examination reveals several more or less important differences, one or two of which may be noted here.

(1) The second maxillipedes are not only entirely coalescent instead of being slightly separated, but they are also more rudimentary than those of *Anchorella emarginata*.

(2) The cephalothoracic portion of the body is proportionally considerably more elongated, being equal to nearly three times the length of the genital part, whereas in *A. emarginata* the cephalothorax is little more than twice the length of the genital segment.

(3) There does not appear to be even a rudimentary abdomen as there is in *A. emarginata*.

The length of the genital segment of the specimen represented by the drawing is about 2·5 mm. ($\frac{1}{10}$ of an inch), which is similar to the size given for *A. emarginata*.

Anchorella scombri, Kurz, appears to have a moderately wide distribution, but is probably not very common; though I have examined a number of Mackerel, only the one specimen of *A. scombri* has been observed. I do not at present know of any other British record for this Copepod, but Dr. Ed. Graeffe records it for the Gulf of Trieste, and states that, according to Kurz, it is found on the gill-arches of *Scomber scombrus*.*

Anchorella (?) *brevicollis*, M.-Edw. (Pl. VIII., figs. 11–16.)

1840. *Anchorella brevicollis*, M.-Edw., Hist. Nat. Crust., vol. iii., p. 418, Ann. Sci. Nat. (3), t. xvi., Pl. VI., figs. 1–3.

This *Anchorella* was found on a Haddock, *Gadus æglefinus*, Lin.,

* Arbeiten der Zoolog. Institute zu Wien, Tom. xiii., Heft. 1, p. 17 (1900). (Separate reprint.)

captured in the Firth of Forth, January 30th, 1896, but only now recorded. It was found adhering, not to the gills, but close to the vent of the fish, and it was the peculiar position it occupied that induced me to take notice of it. It was at first considered to be merely a form of *Anchorella uncinata* (O. F. Müll.), but the further examination of it has revealed one or two differences both in its form and structure which can hardly be reconciled with the characters of that species. The conformation of the body of this specimen of *Anchorella* differs considerably from that of *A. uncinata* in the following particulars:—(1) The neck is comparatively much shorter and stouter, and is more distinctly a continuation of the posterior portion of the body; in *Anchorella uncinata*, on the other hand, the neck is comparatively long and slender, and is more or less distinctly separated by a constriction from the posterior segment. (2) The posterior maxillipedes are distinctly lateral, whereas in *A. uncinata*, as shown in Dr. Baird's figure,* as well as in Pl. VIII., fig. 43, in my paper last year,† the position of these maxillipedes is such that they have the appearance of being a continuation of the genital segment.

The antennules are very small, and two-jointed, but the first is considerably larger than the other, and there are a few minute spines at the apex of the terminal joint (fig. 12). The antennæ are simple and rudimentary; they each consist of a short and stout and apparently uniarticulate appendage (fig. 13). The mandibles are small, and their armature resembles that of the mandibles of *Lernæopoda* rather than of *Anchorella* (fig. 14). The maxillæ are moderately stout; they are each armed with two subapical processes bearing short terminal spines; there are also two minute lateral spines on the same side as the processes referred to, and at a small distance from them (fig. 15). The anterior maxillipedes are comparatively large, the first and second joints are considerably dilated, but the third is narrow, furnished with a stout terminal claw, in addition to two small spines (fig. 16). The abdomen is small, but distinct (fig. 11).

In 1840 M.-Edwards described (op. cit.) an *Anchorella* from the Haddock under the name of *Anchorella brevicollis*; the same species was also obtained on the Haddock by van Beneden‡; and it is to this species that I have provisionally ascribed the specimen mentioned above.

Incerta sedis.

(?) *Lernæopoda* sp. ♂. (Pl. VIII., figs. 4-10.)

A few male specimens of what appears to be a species of *Lernæopoda* were obtained on the gills of an Opah or Kingfish, *Lampris pelagicus* (Gunn.) = (*Lampris luna*, Gmel.), forwarded from Shetland to the Fishery Board's Laboratory at Bay of Nigg, October 10th, 1900; no females were observed. The species is a moderately large one, for the male represented by the drawing measures 4·3 mm. (about $\frac{1}{6}$ of an inch) in length. If in this species the proportional size of the females to the males be similar to that which we find in such species as *Charopinus dalmanni* or *Lernæopoda galei*, the females of this species should reach to about 16–18 mm. in length.

The body of this parasite of the Kingfish is comparatively slender; it tapers more or less gradually towards the posterior end. The antennules are small-and four-jointed, the penultimate joint being shorter than the others (fig. 5). The antennæ are moderately robust, except the last two joints, which are small, and the end-joint is very feebly clawed. The

* Brit. Entom., Pl. XXXV., fig. 9.

† *Eighteenth Annual Report*, Part III.

‡ Les Poissons des Cotes de Belgique, p. 57.

mandibles are small, but somewhat similar in form and armature to those of *Charopinus dalmanni* (fig. 7). The maxillæ are also somewhat similar to those of that species, except that the ends are furnished with two instead of three spiniform appendages (fig. 8). The first and second maxillipedes are very robust, and armed with short but powerful hooked terminal claws (figs. 9 and 10).

The form of the various appendages shows a close relationship with the Lernæopodidæ, closer perhaps with *Charopinus* than with *Lernæopoda*. I am inclined, however, for the present to ascribe the specimens to the latter genus, and to distinguish them from kindred species by the name of *Lernæopoda lampri*.

PART II.—HIRUDINEA AND TREMATODA.

The vermes recorded in the following notes belong to the two great Classes Annelida* and Platyhelmintha. The first includes animals which, for the most part, are free-living, but some are parasitic or predatory. The animals which belong to the second class are, on the other hand, mostly parasitic and live within the bodies of other animals (Entozoa), but some take up their abode on the skin and gills of fishes (Ectozoa), while some others of them are free-living. The Hirudinea comes under the first and the Trematoda under the second of these two classes, and I have grouped my notes to agree with this arrangement.

(A.) The Hirudinea.

The work by which I have chiefly been guided in the preparation of my notes on Hirudines parasitic on fishes is Prof. Léon Vaillant's *Histoire naturelle des Annelés marins et d'eau douce*, vol. iii. (second part), (1890). M. Vaillant divides the Hirudines into the two sub-orders, Bdellariæa and Histriobdellariæa; the first he sub-divides into five families, but the other contains only one. The Hirudines parasitic on fishes belong for the most part to the family Ichthyobdellidæ, one of the five comprised in the first sub-order, and it is only to species belonging to this family that the following notes refer.

Fam. Ichthyobdellidæ.

The leeches included in this family form two more or less distinct groups, both of which are represented by the species recorded here. The leeches contained in the first group (sub-family Branchellionæ) have the body usually divided into two portions more or less obvious by a depression or constriction; the anterior portion, or neck, which is terminated by the head, is less robust than the other; the posterior portion, besides being more robust, is usually furnished with lateral processes which are ramified, lamelliform, or in the form of rounded vesicular tubercles; these processes are non-contractile, and are "destined in every case for branchial respiration"—they do not extend to the anterior portion. One of the most remarkable species belonging to this sub-family is the *Branchellion rhombi* (v. Ben. and Hesse), found living on the Turbot, *Bothus maximus*, at Brest and the Channel, and which may possibly also occur on the same fish in our seas. *Branchellion rhombi* is comparatively a moderately large species, reaching from two to nearly two and a half inches in

* In the Cambridge Natural History, vol. ii. (1896), the Hirudines occupy a position in the classification apparently equal in importance to that of the Platyhelminthes, while the term "Annelida" as the name of a class is set aside.

length; the lateral processes are large foliaceous appendages which extend nearly straight out from the body and impart a singular appearance to the animal. There are several other species of *Branchellion*, but the one mentioned is the only species likely to occur in our seas. The species I now record belongs to another genus of the same sub-family, viz. :—

Genus *Trachelobdella*, R. Blanchard (1894).
[= *Calliobdella*, van Beneden and Hesse (1863).]

Trachelobdella lophii (van Beneden and Hesse).

1863. *Calliobdella lophii*, v. Ben. and Hesse, *Recherches sur les Bdellodes*, p. 36, Pl. II., figs. 11–16.

In this species the body is elongated and rounded, but more so on the dorsal aspect than ventrally. There is, at about a fourth or fifth part of the length of the body from the anterior end, a slight compression, sometimes not very evident in specimens preserved in alcohol, that divides the body into two unequal portions; the posterior portion is furnished with a row of vesicles, along each side, in the form of sphærical tubercles—there are usually twelve to fifteen tubercles in each row; the anterior portion is without tubercles, and forms a kind of simple neck. There is a sucker at each end of the body, that at the anterior end is of an oval form and comparatively small, but the posterior sucker is large and rounded and of a simple structure. No eyes have been observed. The length of this species is stated by van Beneden and Hesse to be about five to six centimeters (from 2 to nearly 2½ inches); probably these measurements were taken from living specimens; our specimens preserved in alcohol scarcely extend beyond three centimeters.

Habitat.—In the gill-pouches of the Angler-fish, *Lophius piscatorius*, captured in the Firth of Forth (1894), and in the Moray Firth (1899). *Trachelobdella lophii* does not appear to be very rare on the Angler-fish. The eggs are very small, and, in general appearance, resemble somewhat the cocoon of a *Bombyx*.

Van Beneden and Hesse record in their *Recherches* one or two other species of *Trachelobdella* which, though I have not yet observed them, may in passing be mentioned here, as they live on the bodies of fishes that are fairly well known and moderately common on our shores.

Trachelobdella punctata (van Beneden and Hesse).

Habitat.—On the body of the Sea Scorpion or Long-spined Cottus, *Cottus scorpius*, *L.* This is a small species, being scarcely two centimeters (about ⅛ of an inch) in length. It has four eyes, arranged in pairs, and each pair is situated on a little conical prominence. There are from fourteen to fifteen round, almost transparent, tubercles along each side of the posterior portion of the body, and by this last character *C. punctata* may be readily distinguished from *Piscicola scorpii*, which lives on the same kind of fish.

Trachelobdella striata (van Beneden and Hesse).

Habitat.—On the body of the common or Black Goby, *Gobius niger*. This species has two eyes, one on each side and near the base of the head; they form little conical eminences, and at a small distance in front of and in line with each eye there is one (? or two) ocular marks which appear to be quite distinct in living specimens. The number of

lateral tubercles in this species is twelve or thirteen on each side. The posterior sucker is ornamented with striæ and white points. This, like the last, appears to be a small species.

The following other species recorded by the authors of the *Recherches* may also be referred to for the reason that it is said to be found commonly in large numbers on the Black Sole, *Solea vulgaris*, viz. :—

Platybdella soleæ (van Beneden and Hesse).

This leech differs from those already mentioned by the possession of only a single pair of respiratory tubercles, one of which is situated on each side of the constriction that separates the two portions of the body. The species is a very small one, being only about 5 mm. ($\frac{1}{5}$ of an inch) in length. The authors quoted state that these leeches not only occur in considerable numbers on the back of the Black Sole, but hold on with such tenacity to the skin that often their bodies are ruptured when removing them from the fish. They are found on Black Soles captured on the coast of France and Denmark, but I do not yet know of any record of their occurrence on Soles captured in our seas.

Sub-Family Pontobdellinæ.

There are, according to M. Vaillant, nine genera in this group of the *Ichthyobdellæ*, but only three of them fall to be noticed here, viz. :— *Piscicola*, *Ichthyobdella*, and *Pontobdella*.

Genus *Piscicola*, Blainville (1827).

In leeches belonging to this genus the body is smooth, usually rounded, and becomes in some species gradually, and to a small extent, enlarged posteriorly, while in others it is of nearly equal thickness throughout. The anterior and posterior suckers are both distinct and equally flattened. The eyes are distinct; their number varies in different species, but is usually four, six, or eight. There are no lateral contractile organs as in species belonging to the Branchellionæ.

The number of species is considerable; several live on marine fishes, but the majority of them appear to be found on fishes that live more or less entirely in fresh water. The *Piscicolæ*, which have a wide distribution in space, are usually separated into three groups, according to the number of their eyes.

Piscicola geometra, Lin., the earliest known species, is found on the Pike, *Esox lucius*, Lin., and other fresh-water species. This species is furnished with eight eyes.

The *Piscicolæ* usually found on marine fishes are provided with six eyes, while those that have four eyes appear, for the most part, to be limited to fresh-water fishes, such as the Perch, Carp, Burbot, and others. Two species,—*Piscicola maculata*, Grube, and *P. quadrioculata*, Malm., —both with four eyes, have been recorded, however, from the Ballan Wrasse, *Labrus berggylta*, the first from the Mediterranean, the other from Norway and Denmark.

Piscicola scorpii, Fabricius.

This species, which belongs to the group provided with six eyes, has occasionally been obtained on specimens of the Sea Scorpion, *Cottus scorpius*, captured by Mr. Williamson in the Bay of Nigg, near the Laboratory, during the past autumn, and to whom I am indebted for the specimens; the same leech was also obtained on a specimen of the Sea

Scorpion captured in the Firth of Forth. One of the largest specimens, preserved in alcohol, measured fully 12 mm. (about ½ an inch) in length.

When living *P. scorpii* is of a reddish or carmine colour, but immersion in alcohol removes the colouring matter from the body, and apparently also from the eyes as well.

Piscicola sexoculata, Malm., has been found on the Cod, but I have not yet observed this species.

Genus *Ichthyobdella*, Blainville (1827).

The species which have been ascribed to *Ichthyobdella* resemble the *Piscicolæ* very closely in their general conformation and structure, so that it is almost necessary for their correct identification that the specimens when examined should be living or but recently dead; it is difficult to correctly identify specimens that have been for a considerable time immersed in alcohol.

The *Ichthyobdellæ* have usually no distinct eyes, and are of a pale colour. The following species have been observed :—

Ichthyobdella sanguinea, Örsted.

1844. *Ichthyobdella sanguinea*, Örsted, *De Region. Mar.*, Elementa topographiæ historico-naturalis Freti Æresund (Dissert. inaug.), p. 80.

1859. *Ichthyobdella anarrhichæ*, Diesing, *Revision der Myzhelminthen.* Abtheilung. Bdell., p. 15.

1863. *Ichthyobdella anarrhichæ*, v. Ben. and Hesse, *Rech. sur Bdell.*, p. 26, Pl. I., figs. 9–13.

1890. *Ichthyobdella sanguinea*, Vaill., *Hist. Nat. des Annelés*, vol. iii., p. 530.

This species is moderately common on the Wolf or Cat Fish, *Anarrhichus lupus*, L. They are found adhering to the gills and inside the mouth as well as on the outside of the body. The specimens I have examined range in length from about 25 to 30 mm., but the authors of the *Recherches* give 30 to 40 mm. as the usual length of the species; a good deal, however, depends on the state of preservation of the specimens.

I. sanguinea has been observed on Catfish captured in the Firth of Forth, the Firth of Clyde, and in the Moray Firth.

Ichthyobdella hippoglossi, Gervais and v. Beneden.

1859. *Ichthyobdella hippoglossi*, Gerv. and v. Ben., *Zoologie médicale*, vol. ii., p. 170.

1863. *Ichthyobdella hippoglossi*, v. Ben. and Hesse, *Rech. sur Bdellodes*, p. 28, Pl. I., figs. 14–17.

A specimen of *Ichthyobdella hippoglossi* was obtained on a Halibut landed at the Fish Market at Aberdeen in June, 1899. The leech was adhering to the inside of the throat of the fish. This is a larger species than the last; the authors of the *Recherches* state that this worm is from five to six centimeters in length, while the specimen I obtained measured about 6·5 cm.

Ichthyobdella marina, Johnston.

1846. *Ichthyobdella marina*, Johnst., Ann. and Mag. Nat. Hist., vol. xvi. (Suppl.), p. 441, Pl. XV.

This species, which has been recorded by Dr. George Johnston from the

Pogge, *Agonus cataphractus*, I have not yet observed. It appears to be a small species, and on that account may have escaped notice.

Other small species of *Ichthyobdellæ*—*i.e.*, *I. rhombi*, van Beneden and Hesse—found on the Brill, and *I. luscæ*, van Beneden and Hesse, found on the Brassy, *Gadus luscus*, have been recorded by Continental students of the parasites of fishes, and these may probably also occur on the same kinds of fishes in our seas.

Genus *Pontobdella*, Leach (1815).

This genus contains the well-known "Skate Leech," *Pontobdella muricata*, Lin., found on different species of Skates and Rays, as *Raia batis*, *R. clavata*, *R. circularis*, and others; and which occasionally occurs on specimens captured by the "Garland." These leeches are readily distinguished from any of the preceding forms by their greater size and corrugated, warty skin.

Several other species of *Pontobdella* are recorded, but the *P. muricata* is the only one known to me as occurring in Scottish waters. But besides the leeches recorded in the foregoing notes, others have been observed on the Lumpsucker, the Ling, and the Plaice; the identification of these, however, is not certain, and consideration of them is delayed meantime.

(B.) The Trematoda.

The Trematoda which I record in the following notes are all ecto-parasites of fishes. A few of them are, in general appearance, not unlike some of the forms referred to under Hirudinea, but the difference between the two groups (A.) and (B.) is usually more or less apparent. These parasites are found living upon the gills and also upon the skin of fishes, and, as will be observed from the records which follow, some of them are apparently not very rare. But though that is so, and though the study of the group opens up an interesting field for practical research, it is worthy of note that very little appears yet to be known regarding the ecto-parasitic Trematodes of the Scottish seas.

The Trematoda have been sub-divided in different ways by different authors; discoveries, real or fancied, bearing on the development and structure of different members of the group have led to modifications in the arranging and classifying of them; but the discussion of such matters being outside the scope of the present paper it is not necessary to dwell upon them; the purpose for which this paper has been prepared is merely to record the various species that have come under the notice of the writer.

In recording the species that fall to be noticed here, I have followed generally the arrangement of MM. van Beneden and Hesse's *Recherches sur les Trématodes Marins*, published in the "Memoirs of the Royal Academy of Belgium," vol. 26 (1863). In this work the Trematoda are divided into the following five families—Tristomidæ, Polystomidæ, Octocotylidæ, Udonellidæ, and Gyrodactylidæ; and the species to be recorded here include representatives of at least four of them. The classification employed by van Beneden and Hesse is here slightly modified so as to be in line with that of vol. ii. of the Cambridge Natural History series; in that work the family Udonellidæ becomes a sub-family (Udonellinæ) of the Tristomatidæ, and the family Octocotylidæ a sub-family (Octocotylinæ) of the Polystomatidæ.

Fam. TRISTOMATIDÆ.

Sub-Fam. TRISTOMATINÆ.

Genus *Epibdella*, Blainville (1827).

Epibdella hippoglossi (O. F. Müller).

1776. *Hirudo hippoglossi*, O. F. Müller, *Zoolog. Dan.*, II., p. 138, Pl. LIV., figs. 1–4.

1858. *Epibdella hippoglossi*, v. Ben., *Mem. sur les vers intestin.* (Suppl. des Comptes Rendus, t. ii.), p. 21, Pl. II. and III.

This Trematode is sometimes very common on Halibut landed from the steam line-fishing boats at the Fish Market at Aberdeen. In this species the body is thin and flat and of an oval form. There are two small suckers in front, one on each side of the head, and a single large posterior sucker; the suckers are situated on the ventral aspect. The one at the posterior end is armed on the under side with several small hooks; they are arranged in two series, with three in each series, the hooks in each series being partly connected with each other end to end, and arranged in a longitudinal line a little to the right and left of the middle of the sucker; each series or line extends from the posterior margin of the sucker inwards towards the centre; the middle hook of each series is the largest, but the posterior one is very small, and can scarcely be made out except under the microscope. The under surface of the sucker, and especially the posterior half of it, is covered with small tubercles, some of which have a bifid apex; they are arranged in lines extending from the centre towards the circumference. A thin, delicate fringe extends around the edge of the sucker, which enables the sucker to be fitted perfectly to any part of the surface of the skin of the fish.

It is interesting to note that Job Baster appears so long ago as 1759 to have described and figured this same Trematode under the name of *Tertia pediculorum species.**

Genus *Phyllonella*, van Beneden and Hesse (1863).

Phyllonella soleæ, van Beneden and Hesse. (Pl. VIII., fig. 17.)

1863. *Phyllonella soleæ*, v. Ben. and Hesse, *Recherches sur les Trématodes*, p. 70, Pl. V., fig. 1–8.

Specimens of this Trematode have been found on Black Soles, *Solea vulgaris*, captured in the Clyde in May, 1897, and again in November, 1899. The specimen represented by the figure (fig. 17) measures about 6·7 mm. (fully ¼-inch) in length. The body is of an oval form, thin and flat. At the anterior end there are two small suckers, one on each side and a little in front of the head; the edges of these suckers are slightly crenulated; the posterior sucker is large, somewhat variable in form, but usually more or less circular, and is surrounded with a very thin flexible border, which permits the sucker to be accurately applied to slight irregularities on the skin of the fish. The sucker is also armed with hooks, as shown in the figure. The surface of the body is covered with minute papillæ, and the colour usually corresponds with that of the fish on which the Trematode lives. This *Phyllonella* is also provided with four distinct eyes; these are only faintly shown in the figure, which represents the ventral aspect.

* J. Baster, *Opuscula subsecciva: observationes miscellaneæ de Animalculi et Plantis quibusdam marinis*, II., p. 138, Pl. VIII., fig. 11 a, A. (1759)

This pretty species does not appear to be very common, and the Clyde is the only part of the Scottish coast from which I have obtained specimens, but my son informs me that he has obtained specimens on *Solea vulgaris* captured off the coast of Lancashire.

Genus *Trochopus*, Diesing (1838).

Trochopus lineatus (sp. nov.). (Pl. VIII., fig. 18.)

A few specimens of this species were obtained in the gill-cavities of a Streaked Gurnard, *Trigla lineata*, captured in the Clyde. It is a small species; the specimen represented by the figure (fig. 18) measures scarcely 3 mm. ($\frac{1}{8}$ of an inch) in length. The body is thin, flat, comparatively smooth, and of a somewhat broadly oval shape. The anterior end is broadly rounded and furnished with two distinct suckers having slightly crenulated margins. The posterior sucker is large and circular; on the under side of it twelve distinct rays are seen, extending at nearly regular intervals from the margin towards the centre; ten of the rays are, at their inner ends, joined to a central and nearly circular ring, which is incomplete only towards its posterior aspect. The two posterior rays have their inner ends apparently free, as the central ring is interrupted at the place where the inner ends of these two rays terminate. A small hook or tooth is situated near the inner end of the ray next in order to and on each side of the two posterior rays just referred to, as shown in the figure. The twelve rays do not reach entirely to the outer edge of the margin of the sucker, but stop short a little way from it, while extending all round the margin is a very thin crenulated fringe, as shown in the drawing.

This Trematode is provided with four distinct eyes, which may be seen even from the under side. The drawing (fig. 18) represents the ventral aspect of the specimen.

Trochopus is closely allied to *Placunella*, one species of which (*Placunella pini*) has been obtained on the Red Gurnard (*Trigla pini*, Bloch, = *T. cuculus*, of Day's British Fishes), and I at one time thought that our specimens might belong to that genus; but *Placunella* appears to differ from *Trochopus* in one or two important points. Not only is the position of the two anterior suckers and the armature of the posterior sucker different, but the posterior sucker in *Placunella* shows a tendency to divide itself into three portions—two lateral sub-circular portions and a middle one; this tendency is more clearly shown in *Placunella rhombi*, which lives upon the Turbot, than in *Placunella pini*, though here also the same tendency may be perceived. In *Trochopus*, on the other hand, the posterior sucker is circular, and without any indication of a tri-partite structure.

Trochopus lineatus resembles somewhat closely the *Trochopus tubiporus* of Diesing, found parasitic on the gills of the Sapphirine Gurnard, *Trigla hirundo*, but in that species the number of rays of the posterior sucker is only nine, whereas in the one I am describing there are distinctly twelve rays, as shown in the figure, and the armature of this sucker appears also to be somewhat different.

One other difficulty encountered in assigning our Trematode to *Trochopus* is that the *nine rays* of the posterior sucker of *Trochopus tubiporus* are made an important generic character. It must be borne in mind, however, that at the time the genus was instituted there was but the one species of *Trochopus* known—viz., the one with the nine-rayed posterior sucker; the number *nine* can, therefore, hardly be considered of more than temporary generic value, and good enough only till another species

possessing a posterior sucker having fewer or more rays should be discovered.

Genus *Tristoma*, Cuvier (1829).

Tristoma molæ, Blanchard. (Pl. VIII., fig. 19.)

Tristoma molæ, Blanchard, Ann. des Sci. Nat., 3 ser., vol. viii., p. 326; *Voy. sur les côtes de Sicile*, p. 129, Pl. II., fig. 2, 2 a.

1863. *Tristoma molæ*, van Ben. and Hesse, *Recherches sur les Trématodes*, p. 77.

A few specimens of this Tristome were taken from a Short Sunfish *Orthagoriscus mola*, sent to the Laboratory, Bay of Nigg, and which had been captured near Mallaig, West Coast of Scotland, in April, 1900. The same Tristome was also taken from a specimen of the Short Sunfish, captured in the Firth of Forth in 1890.

The body of this Tristome is nearly circular, very thin and flat, and the margin is provided with a thin crenulate fringe that extends almost entirely round it.

The specimen represented by the figure measures about 18 mm. (about $\frac{3}{4}$ of an inch) in its longest diameter, but some specimens are slightly longer than that. The posterior sucker is very large, round, sessile, unarmed, and divided into seven compartments by an equal number of rays; the rays scarcely reach to the centre of the disk. The two rays which bound the sides of the compartment at the base of the sucker are joined together by a cross-bar; there is also a central space formed by faint lines joining the inner ends of the seven rays, as shown in the figure (fig. 18).

Tristoma coccineum, Cuv., has been recorded from the Short Sunfish by Couch and referred to by Yarrel,* but this is probably an error, as that Tristome is really a parasite of the Swordfish, *Xiphias gladius*, found in the Mediterranean, and which sometimes wanders to our seas. Van Beneden suggests that the Tristome recorded by Couch may be the *T. papillosa* of Diesing.

Sub-Family Udonellinæ.

Genus *Udonella*, Johnston.

Udonella caligorum, Johnston.

Udonella caligorum, Johnston, Loudon's Mag. Nat. Hist., vol. viii., p. 497.

1858. *Udonella caligorum*, P. J. van Beneden, *Mem. sur les vers intestin.*, p. 13, Pl. I.

Habitat.—Usually attached to the ovisacs and posterior part of the body of *Caligus curtus* found living on the Cod and other Gadoids. This is a very common species on *Caligus curtus*. Van Beneden and Hesse described several other species of *Udonella*, but *U. caligarum* is the only one I have, so far, observed.

* Yarrel, British Fishes, vol ii., p. 438. Yarrel gives two figures showing a dorsal and a ventral view of the Tristome. The ventral view shows the sucker to be seven-rayed like *T. molæ*, but the two posterior rays are not connected by a cross-bar as in that species.

Fam. POLYSTOMATIDÆ.

Sub-Fam. OCTOBOTHRINÆ (OCTOCOTYLINÆ).*

The Trematodes in this group are characterised for the most part by having at the posterior end of the body eight cupules or "suckers," differently arranged in different genera; these cupules are also either sessile (or nearly so), or are situated at the ends of short or moderately long pedicles.

Genus *Octobothrium*, Leuckart (1828).

Octobothrium alosæ (Hermann). (Pl. VIII., fig. 21.)

1728. *Mazocræs alosæ*, Hermann, *Naturforscher*, 17 st., p. 182, t. iv., fig. 13–14.

1828. *Octobothrium alosæ*, Leuckart, *Brev. anim. descript.*, 1828.

1841. *Octobothrium lanceolatum*, Dujardin, *Helminth.*, p. 313.

1858. *Octobothrium lanceolatum*, P. J. van Beneden, *Mem. vers intestin.*, p. 45, Pl. V.

This Trematode lives on the gills of the Allis and Twaite Shads, *Clupea alosa* and *Clupea finta*, and is found sometimes in abundance. The body is elongated and flattened, and of a narrow-lingulate form; it becomes narrower towards the anterior end, which is pointed or rounded; towards the posterior end the width of the middle region of the body becomes slightly less and forms a kind of neck between that region and the part bearing the posterior "suckers"; this part, which, next the neck, is of moderate width, narrows quickly to the posterior extremity, and has a more or less triangular outline; four "suckers" are situated on each of the two margins of this part, while at the apex there are four small hooks, two of which are much larger than the others. At the anterior end there are two small suckers situated to the right and left of the mouth.

As pointed out by van Beneden, the so-called suckers at the posterior end are somewhat different in their structure from true suckers, but are rather of the nature of claws or pincers (his words are "Ce ne sont pas de ventouses, mais plutôt des pinces. Dans chacun de ces organes, on voit deux lèvres mobiles articulées entre elles comme la mâchoire des poissons plagiostomes."‡ Van Beneden gives the length of this species as from 10 to 12 mm.; my specimens do not reach that length, owing probably to their having been immersed for a considerable time in alcohol.

Octobothrium harengi, van Beneden and Hesse.

1863. *Octocotyle harengi*, v. Ben. and Hesse, *Recher. sur les Trém.*, p. 98, Pl. IX., fig. 1–10.

This species lives on the gills of the Herring, *Clupea harengus*. It is of an oblong lanceolate form; the head is at the end of a long, narrow neck; the posterior part, where the eight suckers are situated, is elongate-oval, and the suckers are arranged along the lateral margins, four on each

* As the generic name *Octocotyle* has been set aside in favour of *Octobothrium*, the name of the sub-family requires to be modified to correspond with that adopted for this genus, which is the oldest genus among those arranged in this sub-family.

‡ Vers intestinaux p. 47.

margin, while at the apex four small hooks, two of which are very minute, are observed. The length of this species is somewhat similar to that of the last.

I have only seen one or two damaged specimens of *Octobothrium harengi*; they were obtained on the gills of a herring sent from Annan, Solway Firth, July 30th, 1900.

Octobothrium scombri (Kuhn). (Pl. VIII., fig. 20.)

1830. *Octostoma scombri*, Kuhn, *Mém. Mus. d'Hist. Nat.*, vol. xviii.

1832. *Octobothrium scombri*, Nordmann, *Mikrog. Beiträge*, t. i., p. 77.

1850. *Octocotyle truncata*, Diesing, *Syst. helminth.*, vol. i., p. 422.

1863. *Octocotyle scombri*, v. Ben. and Hesse, *Rech. sur les Trém.*, p. 97.

Habitat.—On the gills of the common Mackerel, *Scomber scombrus*, captured in the vicinity of Aberdeen, August 14th, 1900. *Octobothrium scombri* is a smaller species than the last one, the specimen represented by the figure is only about 5·5 mm. in length,—van Beneden gives 6 mm. as the average length.

The body is linear-lanceolate, very flat and thin; the head is described as being pointed and carried on a neck of the same size, but the worm possesses sufficient mobility to enable it to some extent to change its form. The posterior suckers are arranged in two nearly parallel lines, and they are carried on very short retractile stalks, and there are also at the extremity of the posterior end two comparatively large and two very small hooks, somewhat similar to those observed in the other species of *Octobothrium*. The portion of the body at the posterior end occupied by the eight suckers is more or less distinctly marked off from the middle portion by a narrowing or constriction immediately in front of that portion; and it seems that by this arrangement the two sides of this portion, each with its four suckers, can be folded so as to clasp the gill-filament to which the animal may be adhering.

Prof. P. J. van Beneden states that *Octobothrium scombri* is not common, and that he rarely found more than one or two specimens at one time.* It has been obtained on the gills of the common Mackerel captured on the coast of Belgium and La Manche; my son has also obtained it on Mackerel caught off the Lancashire coast.†

Octobothrium merlangi (Kuhn).

1830. *Octostoma merlangi*, Kuhn, *Mém. du Museum d'Hist. Nat.*, vol. xviii.

1832. *Octobothrium merlangi*, Nordmann, *Mikrog. Beitr.*, vol. i., p. 78, Pl. VII., fig. 1–5.

1895. *Octobothrium merlangi*, T. Scott, Thirteenth Annual Report of the Fishery Board for Scotland, Part III., p. 172, Pl. IV., figs. 23, 24.

Habitat.—On the gills of the Whiting, *Gadus merlangus*, Lin., sometimes not unfrequent, especially on half-grown specimens of the fish. The length of this Trematode is usually about 10 mm., but specimens smaller and others slightly larger are occasionally observed.

* P. J. van Beneden, *Les Poissons des Côtes de Belgique*, p. 37.

† Fourteenth Ann. Rept. of the Liverpool Marine Biology Committee, p. 12 (1900).

The mouth-opening is very near the anterior end of the body, on the under side. This end is very narrow, but the body, which is flat and thin, rapidly expands in width from the anterior end backwards for a short distance, whence the width gradually diminishes to the posterior end, so that the general outline of the body partakes of a leaf-like form.

Towards the posterior end of the body the gradually converging margins send out on each side, and at short intervals, four narrow prolongations which carry little suckers or cupules at their extremities; the prolongations on the one side can be, by the animal, folded over towards those on the other side, so as partly to surround and securely clasp the gill-filament of the fish which for the time forms its host.

I find it to be frequently the case that the form of different specimens of the same species tends to vary more or less, because of their soft and mobile bodies; this is specially observed in specimens preserved in alcohol or removed from the gills of fishes which have been for some time so preserved.

Octobothrium (?) *esmarkii* (sp. nov.). (Pl. VIII., fig. 22.)

Habitat.—On the gills of a specimen of *Gadus esmarkii*, Nilss., captured about sixty miles to the south-eastward of Sumburgh Head, Shetland, in September, 1900. Although a considerable number of specimens of this *Gadus* were examined, only the one *Octobothrium esmarkii* was observed. This appears to be a small species; the specimen represented by the figure scarcely reaches 4 mm. in length and about 2 mm. at the widest part.

The body is thin and flat and is of a broadly ovate form. The anterior end is somewhat wedge-shaped, and separated from the rest of the body by a slight constriction on each side. The posterior end is somewhat truncate; the suckers or cupules are arranged in two rows, with four in each row, along the margins, and towards the posterior end of the body, as shown in the figures; the margins are slightly lobate on that part where the cupules are situated, while the cupules themselves are sessile or nearly so; in front of the anterior cupule on each side the body is slightly constricted. The cupules seen under a moderately high magnification exhibit a somewhat complicated structure, which the artist has tried to show in the figure, but of which it is difficult to give a correct representation; the structure somewhat resembles that observed in the cupules of *Pleurocotyle scombri* (Grube).

I have been unable to find any published description of this species, and I have given to it the name of the fish on which it was observed.

Genus *Phyllocotyle*, van Benneden and Hesse (1863).

Phyllocotyle gurnardi, van Beneden and Hesse. (Pl. VIII., fig. 23.)

1863. *Phyllocotyle gurnardi*, v. Ben. and Hesse, *Rech. sur les Trém.*, p. 103, Pl. .

Habitat.—On the gills of the common Gurnard, *Trigla gurnardus*. The body is narrow-oblong, flat and thin; the head is small, and, in the living animal, is carried on an elongated narrow neck, but in all the specimens preserved in alcohol which I have examined, the head is contracted so as to assume the form represented by the figure (fig. 23). Near the posterior end there are six sessile suckers disposed in two slightly converging marginal lines, three in each line; they are of medium size, and have a very complicated structure. The posterior end of the body is produced into a narrow elongated process, very thin, and apparently retractile, or capable of being folded under the body; I have only seen

this proboscis-like appendage extended in living or recently dead specimens, but have failed to find it in an extended position in specimens preserved in alcohol.* The form which preserved specimens assume is well shown in the figure already referred to. There is at the extremity of the proboscis-like appendage a small cupule or sucker, in which are arranged four hooks--two of moderate size and two very small.

The specimen represented by the drawing, and which had been for some time preserved in alcohol, measures scarcely 2 mm. in length and about ·6 mm. in breadth.

Genus *Anthocotyle*, van Beneden and Hesse (1863).

Anthocotyle merluccii, van Beneden and Hesse. (Pl. VIII., fig. 4.)

1863. *Anthocotyle merluccii*, v. Ben. and Hesse, *Rech. sur les Trématodes*, p. 105, Pl. X., figs. 8–12.

Habitat.—On the gills of a Hake, *Merlucius merluccius*, Lin., landed at the Fish Market at Aberdeen, June 20th, 1900. A few specimens only were obtained.

The authors referred to above give the following as the distinctive characters of this genus:—Four pairs of cupules (cotyles) posteriorly, of which one pair is inflated so as to resemble little bladders, each of which carries hooks and a sucker; the other three pairs, which are small and are borne on little stalks, terminate the body; the body is very thin, but broad in the middle, and very narrow at both the anterior and posterior ends. There appears to be only one described species of *Anthocotyle*—viz., *A. merluccii*.

The length of the specimen represented by the drawing is about 16 mm., but the fish on the gills of which the Trematodes were found had been dead for some time, and the specimen referred to may have been stretched slightly beyond its normal length.

The body is soft, flat, moderately broad in the middle, and considerably narrowed at both ends. The head is small, and is carried on a short, narrow neck; it is provided with a small sucker to the right and left of the mouth; these suckers are capable of being sub-divided by a constriction or septum.

Towards the posterior end, and in front of the lateral bladder-like expansions, the width of the body is considerably diminished, and forms a kind of neck. The lateral expansions are of large size, of a somewhat complicated structure on the ventral aspect, and are each provided with a small sucker on the extreme outer edge (not seen in the drawing). From between these expansions on their posterior aspect there springs a narrow proboscis-like appendage which terminates in six small pediculated and bilobed suckers, three being to the right and three to the left of the apex of the appendage.

The learned authors of the *Recherches* speak of this species as being unquestionably the most strange form that has been discovered belonging to this group of worms. The two lateral appendages, the three pairs of pedunculated suckers which terminate the body posteriorly, together with the cephalic termination of the same, give to the creature a peculiar aspect.

* With regard to this appendage van Beneden and Hesse remark, "Le pédoncule, qui est très-mince et conséquemment très-fragile, manque quelquefois, et alors le trématode parait avoir la partie inférieure tronquée, ou bien il est replié sur ou sous le corps et échappe facilement à la vue." *Recherches*, p. 104.

Genus *Pterocotyle*, van Beneden and Hesse (1863).

Pterocotyle palmata (Leuckart). (Pl. VIII., fig. 27.)

1830. *Octobothrium palmatum*, Leuckart, *Zool. Bruch.*, vol. iii., p. 24, Pl. I., fig. 4.

1853. *Octodactylus inhærens*, Dalyell, *Powers of the Creator*, vol. ii., p. 262, Pl. XXXVI., figs. 1, 2.

1863. *Pterocotyle palmata*, v. Ben. and Hesse, *Recherches sur les Trématodes*, p. 107, Pl. XI., figs. 1–13.

Habitat.—On the gills of Ling, *Molua molva*, captured in the Moray Firth, and also on the same species of fish captured in the Clyde. This parasite is sometimes not uncommon on the gills of the Ling. Dalyell states that on one occasion twenty-nine specimens of various dimensions were removed from a portion of the gills of one of these fishes.

Pterocotyle palmata is a moderately large species; the specimen represented by the figure measures about 20 mm. The form of the body is elongate-lanceolate, slightly wider in the middle than at the anterior end; to the right and left of the posterior extremity are four pediculated sucker-like cupules, which are capable of being sub-divided into at least two compartments by a membranous septum; the eight pedicles—four on each side—extend outwards and backwards so as to have a somewhat fan-like appearance; moreover, the four pedicles of the one group can be folded so as to meet those of the opposite group, and thus form together a very effective clasping organ, by means of which the animal is able to partly enclose and securely grasp the gill-filament of its host.

(?) *Pterocotyle morrhuæ*, van Beneden and Hesse. (Pl. VIII., figs. 25, 26.)

1863. *Pterocotyle morrhuæ*, v. Ben. and Hesse, *Recherches sur les Trématodes*, p. 106.

Habitat.—On the gills of a Cod, *Gadus callarius*, L., about 11¾ inches in length, captured in Aberdeen Bay, November 9th, 1900. I have also observed what appears to be the same Trematode on the gills of one or two Whiting, *Gadus merlangus*. The specimen represented by the drawing is the one obtained from the gills of the Cod; it measures about 8·5 mm. in length, and 3·5 mm. in breadth at the widest part.

The head is small, and carried at the end of a short, narrow neck; the width of the body increases rapidly from the head backwards to near the middle, but the posterior half has the sides nearly parallel. The posterior end is almost truncate, and is provided with six sucker-like cupules arranged nearly in line across the truncate end; from behind the two middle cupules a short and moderately broad and thin prolongation extends backwards and carries at each of its outer angles a cupule somewhat similar to the others; but these two cupules, together with the two immediately in front of them, differ slightly from the other four in that they are borne at the ends of short ventral stalks; figure 26 represents two of these cupules seen in profile. This Trematode, seen from the ventral aspect, exhibits several longitudinal folds or plaits between each of the six cupules that are arranged nearly in line across the posterior end, and the plaits extend forward to near the middle of the body, and are so arranged that these six cupules appear as if they were borne at the ends of peduncles, each of which is joined to the next by an expansion of the dorsal surface. This plaited structure, together with the general outline of the worm, gives it a form not very unlike that of the human hand, opened, and with each finger touching the one next to it.

Although I have ascribed this curious Trematode to *Pterocotyle morrhuæ*, v. Ben. and Hesse; I regard its position here as a somewhat doubtful one. The examination of further, and, if possible, of living specimens, may reveal more clearly its true relationship, but till that is done I prefer to leave it in the genus to which, for the present, it has been ascribed.

Genus *Dactylocotyle*, van Beneden and Hesse (1863).

Dactylocotyle pollachii, van Beneden and Hesse. (Pl. VIII., figs. 28, 29.)

1863. *Dactylocotyle pollachii*, v. Ben. and Hesse, *Rech. sur les Trém.*, p. 110, Pl. XI., figs. 23–30.

Habitat.—On the gills of Pollack, *Gadus pollachius*, L., captured at various times during 1900 in the salmon-nets at Bay of Nigg, near Aberdeen.

This Trematode seen from above is somewhat of the form of an elongated wedge, thin and flat. The head is small, situated near the narrow end. The posterior extremity is broadly truncate, and on both margins at this end there are four peduncles nearly equal in length, furnished with termiual cupules which are divided into two portions by a membraneous septum; the peduncles are entirely free and more or less retractile, and capable of being used as a grasping organ, as shown in figure 29, which represents a Trematode clinging to a gill-filament by means of its pedunculated suckers.*

It would appear from the experiment described below that under certain conditions these parasites though separated from their host are able to survive for a considerable length of time; the experiment may be briefly described as follows:—At 11 a.m. on the 16th of February three specimens of *Dactylocotyle pollachii* were removed from the gills of a Pollack and placed in brackish water having a specific gravity of about 1011. In this medium the Trematodes exhibited at intervals a slow, clumsy, groping movement, as if trying to lay hold of something; there was no attempt to crawl about or move from one place to another, and when placed on their back they did not appear to have even the power to turn over on to the ventral surface. One of the specimens placed in the brackish water soon died, it had probably been injured in the course of removal from the gills of the fish, but the other two continued to be fairly lively. At 11.30 a.m. on the 19th, that is at the end of 72 hours, they were both transferred to clean fresh water, with the result that after a single hour's immersion in this water only faint traces of movement could be observed in either specimen; one of them was then removed back to the brackish water, and after a short time regained some of its former activity. The other one which had been left in the fresh water had at the end of the second hour ceased to move, and, though removed back to the brackish water, it continued motionless, and soon began to change colour. The specimen which had only been left one hour in the fresh water continued to show signs of life up to 4 p.m. of the 21st, or five days and five hours after being removed from the gills of the fish; when examined next morning the creature had succumbed. Probably had the trematode been kept in sea water instead of brackish water it might have lived for a longer time.

The species appears to be a common one on the gills of the Pollack in our seas, and van Beneden and Hesse state that they have found it at all times of the year in great abundance on the gills of the same fish.

The specimen represented by the figure measures about 10 mm.

*These suckers, on their anterior aspect, are beset with numerous minute prickles or spines; but they do not seem to extend round to the posterior aspect. The prickles are easily noticed when the suckers are exserted.

Genus *Onchocotyle*, Diesing (1850).

Onchocotyle appendiculata (Kuhn). (Pl. VIII., figs. 30, 31.)

1830. *Polystoma appendiculatum*, Kuhn, *Mém. du Mus. d'Hist. Nat.*, vol. xviii., p. 362.

1829. *Polystoma appendiculatum*, *idem*, *Ann. des Sc. d'observat.*, t. ii., p. 460, Pl. II., fig. 1-3.

1832. *Polystoma appendiculatum*, Nordm., *Mikrog. Beitr.*, t. i.

1850. *Onchocotyle appendiculata*, Diesing, *System. Helminth.*, vol. i., p. 419.

1858. *Onchocotyle appendiculata*, van Beneden, *Mém. sur les vers intestin.*, p. 54, Pl. VI.

Habitat.—On the gills of the Grey Skate, *Raia batis*, and the Thornback Skate, *Raia clavata*, landed at the Fish Market at Aberdeen in June, 1900.

These parasites are, according to van Beneden, distinguished by a body of extraordinary mobility, a mouth without lateral suckers, and by the body being bifurcated at the posterior end, and carrying at a certain distance from the extremity six large fleshy suckers supported by a stout plate.*

The posterior end is usually folded back upon the ventral aspect of the body. Figures 30 and 31 exhibit a front and side view, showing the position of the six suckers on the recurved posterior end.

P. J. van Beneden found this Trematode in abundance on the gills of *Mustelus vulgaris;* it has also been recorded by the same author from the gills of *Galeorhinus galeus* (L.) and *Scylliorhinus catulus* (Cuv.).

DESCRIPTION OF PLATES.

PLATE VII.

Ergasilus nanus, Edw. v. Beneden.

		Diam.
Fig. 1.	Female, dorsal view	× 51.
Fig. 2.	Antennule	× 116.
Fig. 3.	Antenna	× 102.
Fig. 4.	Foot of first pair	× 96.
Fig. 5.	Foot of third pair	× 96.
Fig. 6.	Foot of fourth pair	× 96.
Fig. 7.	Foot of fifth pair	× 193.
Fig. 8.	Abdomen and caudal farca	× 64.

Caligus scombri, Basset-Smith.

Fig. 9.	Female, dorsal view	× 15·5.
Fig. 10.	Sternal fork	× 102.

Clavella hippoglossi, Kröyer.

Fig. 11.	Male, dorsal view	× 25·5.

Lernæa lumpi, T. Scott (sp. n.)

Fig. 12.	Female, side view (m—mouth)	× 2.

* P. J. van Beneden, Mém. sur les vers Intestinaux, p. 54.

Sphyrion lumpi (Kröyer). Diam.

Fig. 13. Female, dorsal view . . . . . × 5.

Chondracanthus ornatus, T. Scott.

Fig. 14. Female, dorsal view . . . . . × 10.

Charopinus dubius, T. Scott.

Fig. 15. Female, dorsal view . . . . . × 3·5.

Charopinus dalmanni, Retzius.

Fig. 16. Second maxilliped, enlarged.

Charopinus ramosus, Kröyer.

Fig. 17. Female, dorsal view . . . . . × 6.
Fig. 18. ,, side view . . . . . × 6.
Fig. 19. Antennule . . . . . × 154.
Fig. 20. Antenna . . . . . × 102.
Fig. 21. Mandible . . . . . × 128.
Fig. 22. Maxilla . . . . . × 102.
Fig. 23. First maxilliped . . . . . × 51.

Brachiella triglæ, Claus.

Fig. 24. Female, dorsal view, in part . . . . . × 25.
Fig. 25. Antennule . . . . . × 193.
Fig. 26. Antenna . . . . . × 128.
Fig. 27. Mandible . . . . . × 193.
Fig. 28. Maxilla . . . . . × 193.
Fig. 29. First maxilliped . . . . . × 72.

Brachiella ovalis, Kröyer.

Fig. 30. Female, side view, in part . . . . . × 17.
Fig. 31. Antennule . . . . . × 128.
Fig. 32. Antenna . . . . . × 124.
Fig. 33. Mandible . . . . . × 128.
Fig. 34. Maxilla . . . . . × 128.
Fig. 35. First maxilliped . . . . . × 128.

PLATE VIII.

Anchorella stellata, Kröyer.

Fig. 1. Female, side view, showing attachment to scale of fish . × 10.
Fig. 2. Front view of disk showing pellucid markings . . × 33.

Anchorella scombri, Kurz.

Fig. 3. Female, side view . . . . . × 10.

(?) *Lernæopoda* sp.

Fig. 4. (?) Male, side view . . . . . × 14.
Fig. 5. Antennule . . . . . × 154.
Fig. 6. Antenna . . . . . × 154.
Fig. 7. Mandible . . . . . × 193.
Fig. 8. Maxilla . . . . . × 145.
Fig. 9. First maxilliped . . . . . × 77.
Fig 10. Second maxilliped . . . . . × 51.

Anchorella (?) brevicollis, M.-Edw. Diam.

Fig. 11. Female, side view . . . . . × 15·5.
Fig. 12. Antennule . . . . . × 290.
Fig. 13. Antenna . . . . . × 154.
Fig. 14. Mandible . . . . . × 290.
Fig. 15. Maxilla . . . . . × 290.
Fig. 16. First maxilliped . . . . . × 96·5.

Trematodes.

Fig. 17. Phyllonella soleæ, van Beneden and Hesse . . × 10.
Fig. 18. Trochopus lineatus, sp. n. . . . . × 19.
Fig. 19. Tristoma molæ, Blanchard . . . . . × 3.
Fig. 20. Octobothrium scombri (Kuhn) . . . . . × 24.
Fig. 21. ,, *alosæ*, Hermann . . . . . × 20.
Fig. 22. ,, esmarkii, sp. n. . . . . × 19.
Fig. 23. Phyllocotyle gurnardi, van Beneden and Hesse . . × 34.
Fig. 24. Anthocotyle merluccii, van Beneden and Hesse . . × 6.
Fig. 25. Pterocotyle morrhuæ, van Beneden and Hesse. . . × 8.
Fig. 26. ,, ,, side view of the central suckers . . × 10.
Fig. 27. ,, palmata (Leuckart) . . . . × 4.
Fig. 28. Dactylocotyle pollachii, van Beneden and Hesse . . × 7.
Fig. 29. ,, ,, showing specimen attached to a gill-filament . . . . . × 6.
Fig. 30. Onchocotyle appendiculata (Kuhn) . . . . × 7½.
Fig. 31. ,, ,, side view, showing arrangement of suckers . . . . . × 7½.

V. ON THE RATE OF GROWTH OF THE COD, HADDOCK, WHITING, AND NORWAY POUT.—By T. WEMYSS FULTON, M.D., F.R.S.E., Scientific Superintendent. (Plates IX.–XVI.)

CONTENTS.

Introduction,	154
The Norway Pout,	155
Deep-Water Hauls,	155
Hauls off Aberdeenshire,	160
Hauls in Moray Firth,	161
Hauls in Firth of Clyde,	161
Summary,	164
The Whiting,	166
Hauls in Aberdeen Bay,	166
Hauls in Deep Water,	175
Hauls in Moray Firth,	178
Summary,	185
The Haddock,	190
Hauls in Aberdeen Bay,	190
Hauls in Moray Firth,	199
Hauls in Deep Water,	203
Summary,	211
The Cod,	214
Hauls in Aberdeen Bay,	214
Hauls in Moray Firth,	218
Hauls in Deep Water,	222
Summary,	227

Introduction.

In the following pages are given the results of an investigation on the rate of growth of the cod, haddock, whiting, and Norway pout. The method adopted consisted in the measurement of the fishes named which were caught in a trawl-net on various occasions in Aberdeen Bay, the Moray Firth, the off-shore grounds, and the Clyde, for the most part by the steam-trawlers "St. Andrew" and "Star of Hope," and to a small extent by the s.s. "Garland." In the former case the cod-end of the large otter-trawl used in ordinary fishing operations was enclosed in a bag of fine-meshed netting which caught the fishes that escaped through the meshes of the otter-trawl. These were placed in a weak solution of formaline in tanks and taken to the Marine Laboratory at Bay of Nigg, where they were measured. The fish taken in the trawl-net itself were measured on board. In the case of the "Garland" the fishes were first soaked in formaline and then forwarded to the Laboratory.

The numbers of the various species dealt with were as follows:—Cod, 2493; haddock, 9346; whitings, 18,466; Norway pout, 3937—the total being 34,242. The length of each fish in millimetres ($\frac{1}{25}$-inch) was recorded on a form prepared for the purpose, and the measurements grouped themselves on each side of a maximum or average, according to the annual series or generation represented. These in some cases, as in the Norway pout, were very distinct from one another, and there was no difficulty in separating the early generations in this way. Owing, however, to the variation in the rate of growth of individual fishes, and the accentuation of this variation with age, one series or generation may become blended more or less with the next, and it was thus found to be a matter of extreme difficulty to separate the older generations. Further observations are required with regard to these, particularly in the case of the

cod. After one group or generation had been satisfactorily separated from another, the number of fishes under each millimetre measurement within the limit of the group was then ascertained, and the number of millimetres and the number of fish were multiplied together. This was done in each case, and the sum of the products was divided by the number of fish in the group, which gave the mean or average size of the fishes of the group at the date when they were caught. It will be found that unless when the number of fishes is small the correspondence of the averages in different hauls at the same place and time is very close. By comparing the mean size of one series with that of the next higher series at the same date and place the apparent increment of growth in one year was ascertained; and by comparison of the mean size of the fishes in one and the same series at different dates the amount of growth in the interval was determined.

The method adopted was first made use of by Dr. Petersen in investigating the rate of growth of the plaice; and, as will be seen in the sequel, it might also be useful in throwing light on the migrations of fishes, if carried out systematically and on a proper scale. The measurement of the small fishes caught in the fine-meshed net were made by myself; but in measuring those caught in the otter-trawl I received much assistance from Mr. H. Dannevig, who also undertook this work when I was not on board and recorded the measurements in deck-books. All the measurements of fishes caught in the otter-trawl during the trip of the *St. Andrew* to the deep-water grounds in October were made by Mr. Dannevig. I have also to thank Mr. P. Jamieson for assistance in the enumeration and measurement of the fish.

THE NORWAY POUT (*Gadus esmarkii, Nilsson*).

As I have stated elsewhere in this Report (p. 282), the Norway pout was found in abundance in the deeper waters of the North Sea, and also in water of moderate depth off Aberdeen Bay and in the Moray Firth. It is convenient to consider the rate of growth of this species first, both because large numbers were taken in single hauls, and because the young fishes are found on the same grounds with the older individuals. The groups of fishes of one season are pretty sharply divided from those of the following season, except in the case of the older forms, and we are thus able to decide with considerable accuracy their respective limits and rate of growth.

I. Deep-Water Hauls.

The fish caught in the hauls in the deeper water may first be dealt with. These hauls were four in number, viz., on 31st August and 4th September at a spot approximately 65 miles S.E. by E. of Sumburgh Head, Shetland, and in depths of from 62 to 66 fathoms; and on 16th and 19th October at a spot about 16 miles S.E. of Fair Isle, in depths of 60 and 65 fathoms repectively. They were all made on board the steam-trawler "St. Andrew," the cod-end of the trawl-net being enveloped by a bag of fine-meshed (½-inch mesh) netting in the way elsewhere described (*see* p. 62), and it was in this outer net that the specimens of this species were captured.

(1) *Hauls in August and September.*

In the first haul, on 31st August, which lasted for 30 minutes, and was

made in 66 fathoms, the number taken was 551, and their sizes, grouped in centimetres, are as follows :—

10	11	12	13	14	15	16	17	18	19	20	21	22
0	1	29	200	176	48	22	46	19	7	2	1	0

The smallest specimen measured 110mm., and the largest 213mm. On grouping the numbers of fish under each millimetre between the two extreme sizes mentioned it was obvious that they were divided into two annual series, the first beginning at 110mm. and terminating at or about 162mm., the second beginning at the latter point and ending at 213mm. This is more clearly shown by arranging the first in ·5cm. groups, from a little before the place of division (from 14cms.), as follows :—114, 63, 28, 20, 7, 15, 25, 21, 14, 5, 6, 1, 1, 0, 1—

The first series comprises 460 fish, the smallest measuring 110mm., the next 120mm., and the next 124mm.; the largest measures 162mm., and the range from the smallest to the largest in this series is therefore 52mm., or barely over two inches. The mean or average size of the 460 fish is 140·2mm., or slightly more than 5½ inches.

The range of the second series, which contains 91 fish, is nearly the same, viz., 50mm.; and the mean or average size is 176·8mm., or close upon seven inches. The difference between the mean of the two groups is therefore 36·6mm., or barely 1½ inches, and this represents the increment of growth in the course of a year.

The haul of 4th September, on the same grounds,* in 62½ fathoms, lasted for two hours, and the number of *Gadus esmarkii* taken was 1211 (Pl. IX.). Arranged in centimetre groups according to their sizes they are as follows :—

4	5	6	7	8	9	10	11	12
0	2	39	410	178	3	0	3	112

13	14	15	16	17	18	19	20	21
270	97	26	34	28	5	3	1	0

In this haul the smallest specimen measured 51mm., and the largest 200mm., and when they were arranged, as before, according to their lengths in millimetres they fell into three groups or series. The first series, not at all represented in the previous haul, comprised 632 fishes ranging from 51 to 92mm., with a difference therefore between the largest and the smallest of 41mm. The mean or average size of this group was 78·7mm., or scarcely 3⅛ inches. There was no fish at all between 92mm. and 117mm., the size of the smallest specimen of the second series, so

* The vessel continued fishing in the same locality, but the distance between the spots where the two hauls were made may have amounted to several miles, perhaps fifteen.

that these two annual groups are very distinctly divided from one another. The second series comprised 498 fishes, ranging in length from 117mm. to 155mm. or thereabouts, with a range between the smallest and the largest of 38mm. The average size of this group was 136·0mm., or about $5\frac{3}{8}$ inches.

The division between the second and third series is not so distinct as between the first and third. When arranged in ·5cm. groups the numbers of fish at the place of junction and to the end of the series are as follows, starting from 14cm., viz.—71, 26, 14, 12, 15, 19, 15, 13, 3, 2, 2, 1, 1, 0. In groups of 2mm., from 145mm. on to 168mm. they dispose themselves thus:—16, 12, 8, 5, 4, 2, 5, 7, 7, 6, 7, 10. The lowest number, viz.—2 at 155mm.—is taken as the point of division. The number of fish in this third series was 81, measuring from 157mm. to 200mm., with a difference between the largest and the smallest of 43mm. The average size of the 81 fish was 168·9mm., or a little over $6\frac{5}{8}$ inches.

According to the measurements of the fish in this haul, then, the differences between the average size of those in each of the annual groups or series is: Between the first and second, 57·3mm., or about $2\frac{1}{4}$ inches, and between the second and third, 32·9mm., or about $1\frac{5}{16}$ inches. These differences represent the extent of the mean annual growth between the series.

The measurements of the fish in the two hauls above detailed may be thus represented in annual series:—

31st August.					
	No.	Average Size.	Range of Size.	Difference.	Annual Growth.
1st Series, .	...	...	...	...	...
2nd Series, .	460	140·2	110-162	52	...
3rd Series, .	91	176·8	163-213	50	36·6

4th September.					
	No.	Average Size.	Range of Size.	Difference.	Annual Growth.
1st Series, .	632	78·7	51–92	41	...
2nd Series, .	498	136·0	117–155	38	57·3
3rd Series, .	81	168·9	157–200	43	32·9

It will be seen that the results of the measurements of the two hauls do not quite correspond. In the earlier haul both the average size, the range of size, and the increment of growth are somewhat greater than in

the second haul. The average size of the second series is greater by 4·2mm., or $\frac{1}{8}$ of an inch, not a very considerable difference; the average size of the third series is 7·9mm., or about $\frac{1}{3}$ of an inch greater. The annual increment of growth between the second and third series calculated on the first haul is 3·7mm., or $\frac{1}{7}$ of an inch, greater than that calculated on the second haul—an inconsiderable difference. There is more difference between the range of sizes in the series, but this is not so important, because as the point of division is determined by the curve of the respective numbers, the inclusion or exclusion of one or a few specimens at either end of the series is of little or no importance in modifying the average size deduced, unless the whole number be small. Thus in the haul of 31st August there were two large fish of 204 and 213 mm., while in the haul of 4th September the two largest were 196 and 200 mm. If the two former be omitted from the calculation the variation of size in the series will be reduced to 37mm., or ·6mm. lower than the difference of the range in the haul of 4th September, while the average size of the series will fall by only 0·4mm., although the series contains only 81 fish.

Since the two hauls were taken on the same grounds, with an interval of only four days, the measurements might be combined in order to furnish an average deduced from a greater number of fish. If this be done, then we get an average size for the 958 fish comprising the second group or series of 138·1mm., and of 173·6mm. for the 172 fish of the third series, showing an annual rate of growth of 35·5mm. between the two generations.

(2) *Hauls in October.*

Two hauls were made in October with the fine-meshed net enveloping the cod-end, one on the 16th and one on the 19th, both in the same locality, about 16 miles S.E. of Fair Isle. The haul on the 16th, which was in 65 fathoms and lasted one hour and a half, yielded 1923 specimens of *Gadus esmarkii* (Pl. IX.). They varied in size from 66mm. to 197mm., the centimetre groups being as follows:—

5	6	7	8	9	10	11	12
0	2	79	916	517	24	2	11
13	**14**	**15**	**16**	**17**	**18**	**19**	**20**
122	158	64	15	9	2	2	0

In this case also, as in the haul of 4th September, we have three generations or annual series represented, but the size and distinctness of the third of these is not so definite. The first series comprises 1540 fish ranging in size from 66mm. to 115mm., with a difference between the largest and the smallest of 49mm. The average size of this series, calculated from the millimetre measurements, is 87·7mm., or barely 3½ inches.

The second annual series comprises 373 fish, and begins at 124mm., a gap of 8mm. separating it from the previous series. The end of the

series is not, however, so readily defined. The two-millimetre grouping, from 155mm. on, is as follows:—

9, 7, 8, 2, 2, 2, 4, 1, 2, 0 | 0, 4, 3, 0, 0, 0, 1, 0, 0, 1, 0, 1, 0.

I have placed the point of division at 172mm.; it might perhaps be placed at 169mm., which would exclude three fish, but would not make any material change in the average size (viz. 0·2mm.). According to the division indicated, the average size of the fish of this generation is 143·5mm., or $5\frac{6}{8}$ inches, showing an increment of annual growth of 55·8mm., or $2\frac{3}{16}$ inches. This corresponds pretty closely with the increment of annual growth deduced from the measurements of the fishes taken in the haul of 4th September—viz., 57·3mm., being only 1·5mm. less.

The third series in this haul is, as already indicated, imperfect, comprising only ten fishes from 177mm. to 197mm., with an average size of 182·5mm. The number is too small to form a trustworthy basis for the average size.

The haul on the 19th October in the same locality, in 66 fathoms, lasted also for an hour and a half, and the number of *Gadus esmarkii* captured and brought to the Laboratory was very large—viz., 5084. Time could not be spared to measure and record the measurements of all these, but this was done for 257 of them. Of these, 11, ranging from 75 to 96 mm., clearly belonged to the first series, and also, I think, two at 110 and 116 mm., although the latter might fall into the second group. The average of so small a number is not, perhaps, of much value, but, on the assumption stated, it was 86·9mm., which is only 0·8mm. lower than the average for the corresponding series in the previous haul.

The next series contained 243 fishes, ranging from 119mm. to 168mm., showing a difference of 49mm. between the largest and the smallest of the same generation. The average size was 143·7mm., or almost exactly the same as the corresponding average in the haul on the 16th, which was 143·5mm. The third series was not represented among those measured.

This haul was valuable for a special reason. I had observed that when the bag of fish was swung on board the smaller fishes sometimes protruded from or passed through the meshes of the fine-meshed net around the cod-end. I accordingly had the end of the fine-meshed net enclosed loosely for about a yard up with fine mosquito netting, in order, if possible, to catch the very small fishes that escaped before the net was brought on board. It was, however, found that the pressure of the water passing through the mosquito netting at the rate at which it was towed burst it; but notwithstanding this a few of the smaller fishes were discovered in its folds, and among them was a specimen of *Gadus esmarkii* only 31mm. in length. The discovery of so small a specimen in October which had passed through the fine-meshed netting hitherto employed is of interest. The smallest specimen of this series in the other haul in October was 66mm.; in the haul at the beginning of September it was 51mm. The difference in size thus amounts to 35mm. So great a difference might lead to the supposition that the specimen belonged to another series, but the most likely explanation is that it was a small individual of the same group, probably in the pelagic stage, the others having escaped capture. The circumstance shows that the limits and averages of this series cannot be accurate, and would be considerably modified if a complete collection of the smaller sizes could be made. A thorough exploration of the intermediate layers of water with suitable apparatus is much to be desired.

Comparison may now be made between the averages for the hauls in August and September and those for October, in order to ascertain the

increment of growth in the interval, and also to see how this increment agrees with the annual increment deduced from the comparison of the various series at the same date.

The 632 fishes of the first series in the haul of 4th September had an average size of 78·7mm. In the haul of 16th October the corresponding average size of the 1540 fishes was 87·7mm. The increase in length of this generation in the interval of 42 days which elapsed between the hauls was therefore 9mm., or at the rate of ·2143mm. per day. On this basis the average increase of length in a year ought to amount to 78·2mm., on the assumption that the rate of growth was uniform throughout the year. But we have seen that the increment of annual growth between the first and second series in the September haul was 57·3mm., which would, at the rate indicated, represent a continuous growth for only 267 days (267·4) out of the 365. In the haul on 16th October the corresponding annual increment was 55·8mm., which, on the same basis, is equivalent to continuous growth for a period of 260 days (260·4). The mean of these numbers would indicate continuous growth for 264 days. It is well known—although the subject still requires more exact investigation—that the growth of fishes is greatly retarded or arrested during the winter months, and this circumstance no doubt explains the variations stated. In this case the numbers appear to show complete arrest of growth for 101 days, or three months and about ten days; but as the seasonal change in the temperature of the sea is gradual, sinking from October to March, and rising thereafter, it is probable that the retardation of growth is also gradual and extends over a longer period than that described above.

The average size of the second series of fishes in the September haul, 498 in number, was 136·0mm. In the haul of 16th October the corresponding average was 143·5mm., and in the haul of 19th October it was 143·7mm. The average increase in length in this generation was therefore 7·5mm. in the interval of 42 days in the one case, and 7·7mm. in the interval of 45 days in the other case, or a mean increase of 7·6mm. in 43½ days. This is equivalent to a rate of growth of ·1747mm. a day—less, therefore, than in the smaller fish of the previous generation—and to an annual increment in a year of 63·8mm. The calculated annual increment of this series in the September haul was 32·9mm.; and this would represent, at the rate indicated, continuous growth for only 188 (188·3) days, and arrest of growth for 178 days, or nearly six months. The average annual increment according to the haul in August was 36·6mm., which is equivalent, on the same basis, to continuous growth for 209 (209·5) days, and arrest of growth for slightly over five months. In this generation, therefore, it would appear that not only the amount of annual increment is less than in the previous generation, but that retardation of growth in the winter is more prolonged.

II. Hauls off Aberdeenshire.

In October and November specimens of *Gadus esmarkii* were procured by the "Garland" off the coast at Aberdeen (*see* p. 282). On the 12th October 26 were taken by the shrimp-trawl in 32½–33 fathoms, ranging in size from 59 to 107 mm., and belonging to the same generation as the A series in the other hauls. The one next in size to the smallest was 78mm. in length, showing an interval of 19mm. The average size of the lot was 96·3mm., or about 3⅞ inches. Other hauls on 23rd and 24th October, in from 36 to 60 fathoms, yielded 201 specimens. Of these, 200, ranging in size from 87 to 117 mm. form a first series, with an average

length of 101·8mm., or 4 inches, a range of 30 mm. There was also one which measured 164mm. and represented the next annual series or generation.

On November 7th, a haul, in from 45–53 fathoms, yielded 63 specimens, of which 60 ranged from 80 to 117 mm., and two measured 168 and 170 mm. respectively. The average size of the former group was 102·9mm. Another haul on the 9th November, made with the small-meshed net over the cod-end of the large otter-trawl of the "St. Andrew," in 9 to 10 fathoms, produced 51 specimens from 83 to 114 mm. in length, the average being 99·2mm.

The averages are high when compared with the corresponding averages of the hauls off Fair Isle in October, viz., 86·9 and 87·7 mm. This may be partly due to the smaller numbers from which the averages are derived, although all the four averages for the Aberdeen coast are larger; or to the smaller fishes of the series remaining for the most part further offshore, which again is not supported by the capture of one at 59mm. It may not improbably be owing in reality to a greater rate of growth in the waters near the shore, which seems to be also exhibited in some other cases. Comparison of the averages of the hauls by the "Garland" rather supports this explanation, showing between 12th October and 23rd October and 7th November, respectively, increments of increase of 4·1mm. in 11 days and of 5·2mm. in 26 days. On the other hand, the increase in the 15 days between 23rd October and 7th November, when the bottom temperature had fallen 1·8° F., was only 1·1mm. The average of the "St. Andrew's" catch on November 9th was only 99·2mm., less therefore than the "Garland" averages, except the one on October 12th, but greater than the average of the fish caught off Fair Isle on 19th October, with the same net, by 12·3mm., while the increase in the 21 days, calculated on the basis previously referred to of a daily increment of ·2143mm., would amount to only 4·5mm. The number of specimens in the hauls off Aberdeen was, however, comparatively small.

III. Hauls in the Moray Firth.

In the Moray Firth four specimens of *Gadus esmarkii* were taken in 35 fathoms to the east of Smith Bank. They measured 84, 91, 92, and 93 mm. One, 114mm. long, was caught in Dornoch Bay on 7th November; other four were procured off Lossiemouth and towards Tarbet Ness on the 3rd and 4th of the same month. All these belonged to the first series referred to above, but they afford no particulars as to average or range.

IV. The Firth of Clyde.

Specimens of *Gadus esmarkii* from the Clyde were obtained occasionally in 1899 and in March 1900, but they were as a rule small in numbers.

A haul on 30th August 1899, in 49 fathoms, in the outer part of the Firth between Pladda and Bennan Head, yielded 21 specimens varying in size from 122mm. to 149mm. The average length was 139·1mm., which agrees pretty closely with the corresponding average of 140·2mm. obtained on 31st August 1900, in the deep water of the North Sea. Another haul made in Kilbrennan Sound, in 30 fathoms, on 5th September, furnished 20 specimens, ranging in size from 125 to 150 mm. and having an average size of 141·4mm. This is 5·4mm. above the corresponding average for the deep-water North Sea specimens on 4th September 1900. On 6th October, a haul, in 65 fathoms, at the mouth of the Firth, produced 74 specimens comprising two well-marked groups. The first consisted of 15 fishes,

from 85 to 109 mm., with an average size of 95·5mm., which is only 0·7mm. below the corresponding average for Aberdeen Bay on 12th October, and is 7·8mm. more than the corresponding average for the deep water off Fair Isle on 16th October. The second series comprised 59 fishes ranging from 118 to 156 mm., and with an average size of 133·4mm. This is 5·7mm. lower than the average of the series in the haul of 30th August above referred to, and 10mm. lower than the October averages for the deep water in the North Sea. The difference between the averages for these two Clyde series is 37·9mm., which would represent the increment of annual growth. This is much lower than the September and October corresponding averages for the deep water of the North Sea, which were 57·3, 55·8, and 56·8 mm. respectively, and there is little doubt the discrepancy is due to the small numbers of the Clyde specimens.

I append a Table of the measurements and averages of the various hauls.

Date.	No. of Fish.	Size—In Millimetres.				Apparent Annual Growth.
		Range.	Difference.	Average.		
Aug. 31.				Mm.	Inches.	Mm.
B Series .	460	110–162	52	140·2	$5\frac{1}{2}$	..
C „ .	91	163–213	50	176·8	7	36·6=$1\frac{7}{16}$"
4 Sept.						
A Series .	632	51–92	41	78·7	$3\frac{1}{8}$	..
B „ .	498	117–155	38	136·0	$5\frac{3}{8}$	57·3=$2\frac{1}{4}$"
C „ .	81	157–200	43	168·9	$6\frac{5}{8}$	32·9=$1\frac{5}{16}$"
Av. B Series	*958*	*110–162*	*52*	*138·1*	*$5\frac{7}{16}$*	..
Av. C „	*172*	*157–213*	*56*	*173·6*	*$6\frac{13}{16}$*	*35·5=$1\frac{3}{8}$"*
16 Oct.						
A Series .	1540	66–115	49	87·7	$3\frac{1}{2}$	..
B „ .	373	124–172	48	143·5	$5\frac{5}{8}$	55·8=$2\frac{3}{16}$"
C „ .	10	177–197	10	182·5	$7\frac{3}{16}$	39·0=$1\frac{9}{16}$"
19 Oct.						
	[1	31	..	31]	..	..
A Series .	13	75–116	41	86·9	$3\frac{7}{16}$	..
B „ .	243	119–168	49	143·7	$5\frac{5}{8}$	56·8=$2\frac{1}{4}$"
Aver. Oct.						
A Series .	*1553*	*66–116*	*50*	*87·7*	*$3\frac{7}{16}$*	..
B „ .	*616*	*119–172*	*53*	*143·6*	*$5\frac{5}{8}$*	*55·9=$2\frac{3}{16}$"*

Date.	No. of Fish.	Size—In Millimetres.				Apparent Annual Growth.
		Range.	Difference.	Average.		
			Aberdeen Bay.			
12 Oct.				Mm.	Inches.	Mm.
A Series .	26	59–107	48	96·3	$3\frac{3}{16}$	..
23, 24 Oct.						
A Series .	200	87–117	30	101·8	4	..
B „ .	1	164	..	164	..	..
7 Nov.						
A Series .	60	80–117	37	102·9	$4\frac{1}{16}$	..
B „ .	2	168–170	..	..	..	..
9 Nov.						
A Series .	51	83–114	31	99·2	$3\frac{7}{8}$	..
30 Aug.			Clyde.			
B Series .	21	122–149	27	139·1	$5\frac{1}{2}$	..
5 Sept.						
B Series .	20	125–150	25	141·4	$5\frac{9}{16}$	..
6 Oct.						
A Series .	15	85–109	24	95·5	$3\frac{3}{4}$	..
B „ .	59	118–156	38	133·4	$5\frac{1}{4}$	*37·9*

SUMMARY.

The spawning period of the Norway pout and the size at which maturity is reached do not appear to be well defined. Collett found gravid females in January and February*; and Holt† found two females ripe on 7th and 8th April on the Irish coast, each of which was $4\frac{1}{2}$ inches in length. Another female, considerably larger, was found to be spent on 4th July; and the pelagic eggs were taken, in small numbers, in April. It is therefore probable that the Norway Pout spawns chiefly in March and April. Those obtained by myself at the above dates were immature. Specimens of 133mm. and 140mm., caught on 4th September, had eggs 0·1mm. in diameter and would no doubt spawn in the ensuing spring.

* Fries, Ekström, and Sundevall, "Scandinavian Fishes," i., 510.

† *Roy. Dubl. Soc. Rep. of Council*, Dec. 5th, 1891, App., p. 291.

If April be taken as the principal spawning-time, and if the female reaches maturity at 4 or 4½ inches (114mm.), as Mr. Holt found to be the case, it is evident that on the assumption that the series A above described was spawned in the spring of 1900 sexual maturity must be attained at an early age. This series on 4th September had an average size of 78·7mm. or 3⅛ inches, and specimens belonging to it varied from 2 inches to 3⅝ inches. In October the average fish of the series was 3 7/16 inches long, and some individuals reached a length of 4 9/16 inches; that is to say, the size at which the female has been found mature. This fact would almost suggest that the series did not belong to the year's brood, and the rate of growth deduced from comparison of the averages at different periods and of different series is also striking. The greatest average growth in a year between series A and series B is 56·8mm. or 2¼ inches; and the amount of growth in the series (A) in the interval of 42 days between 4th September and 16th October was, as stated, 9·0mm., or at the mean rate of ·2143mm. per day. At this rate the increment of growth from the end of April to 4th September would be only 27mm, and to 16th October 36mm., instead of 87·7mm. One might thus consider the year's brood to be represented by the single specimen, caught on 19th October, which was 31mm. in length, and Collett* found young specimens "at least 40mm. long" in quantities among the sprats caught in nets in autumn.

The rate of growth in autumn, however, upon which the above calculation is based, is doubtless considerably less than it is in summer; and it appears that, although there is little exact evidence except in the case of the herring, the growth of post-larval round fishes is very rapid in the warm months. Moreover, the assumption that series A were fish of the previous year would imply that they had lived through two summers and had only reached an average length of under four inches in their second autumn. The series must be regarded as the brood of the year.

The next or B series, with an average length in the hauls 31st August —4th September of 138·1mm. or 5 7/16 inches, and a range from 4 5/16 inches to 6⅜ inches, would at this time be about 1 year and 4 months old; and many of them, at all events, on the evidence of maturity furnished by Holt, would have spawned in the previous spring. The increment of growth, at the rate already mentioned, from the beginning of April to the 2nd September would be about 33·2mm.; it would probably in reality be greater, because the rate of growth in the middle of summer is no doubt quicker than in the period from 4th September to 16th October. But taking it at this figure, and deducting the amount from the sizes in the August-September hauls, the average size of the series at the beginning of April would be about 105 mm. or 4⅛ inches. Deducting the same amount from the largest member of the series in these hauls, viz., 162mm., these fishes at the beginning of April would measure about 5 inches. While many, therefore, would not reach the size of maturity as found by Holt when one year old, it appears that a considerable proportion of them would.

The average size of this series in the October hauls was 143·6mm. or 5⅝ inches, and they no doubt form the principal breeding stock in the following spring, when two years of age.

The next series, is best represented in the August and September hauls. It has then an average size of 173·6mm. or very nearly seven inches, and the mean age would be about 2 years and 4 months. The largest specimen measured 213mm. or 8⅜ inches, and the smallest 6 3/16 inches.

The annual increment of growth between the previous series B and this series, as deduced from comparison of the averages, is, in the three cases

* "Scand. Fishes," i., p. 510.

where series C existed, respectively 36·6, 32·9, and 39·0mm., giving a mean of 36·1mm. If the last be excluded, as depending upon ten fish only, then the mean growth in a year amounts to 34·7mm. or $1\frac{3}{8}$ inches. The annual increment between series A and series B is represented in the differences between the averages as 57·3, 55·8, and 56·8mm., the mean being 56·6 or nearly $2\frac{1}{4}$ inches.

In these hauls, then, at least three generations of *Gadus esmarkii* were represented, having, in October, the following average ages and sizes:—

Series A	-	87·7 mm.	($3\frac{7}{16}$ inches)	0 years	5–6 months.
„ B	-	143·6 „	($5\frac{5}{8}$ „)	1 „	5–6 „
„ C	-	182·5 „	($7\frac{3}{16}$ „)	2 „	5–6 „

It would appear from these data that the Norway Pout rarely lives to be over three years of age. The largest specimen from Bohuslän is described by Fries, Ekström, and Sundevall as a little under 19cm. in length, and they say that Collett gives 240mm. as the maximum length of this species within his experience.* That is 27mm. above the largest obtained by me, in the North Sea, and 66·4mm. above the mean size of series C in August-September, and Collett's specimen would probably be at least four years old. The largest specimen obtained by me (from the Clyde) was 246mm. in length.†

This restriction of the age and size is not, I believe, due to any innate cause of mortality or to marked cessation of growth, but rather to the fact that the fish are eaten by others and hence do not survive to attain a greater age or larger size. It is preyed upon by other fishes, such as the cod, haddock, and whiting, which frequent the same grounds, and was not uncommon in the stomach of the Angler (from which some of the best-preserved specimens were obtained); and Holt has found it in the stomach of the Tope, gurnard, witch, cod, turbot, whiting, pollack, and ling (*op. cit.*, 290). This circumstance, as well as the diminished rate of growth, may perhaps serve to explain the comparatively small difference between the averages for series B and series C. It is also noteworthy that fishes of this series C were much less numerous in the October hauls than in the earlier ones. In those of August and September they formed 9·8 per cent. of the total of 1762 fishes; in October they formed less than a half per cent. The portion that survived to spawn in the following spring would be very small indeed.

THE WHITING (*Gadus merlangus, L.*).

The whiting presents difficulties in determining the rate of growth somewhat greater than in the case of the Norway Pout, inasmuch as migrations, especially of the young, occur between the offshore and inshore grounds, and the different sizes or generations may not be found in due proportion in the same locality, and are more blended one with another. The measurements and observations are, however, more numerous (18,466 fish being included), and it will be convenient to consider first those hauls comprising the greatest number of fish.

I. Hauls in Aberdeen Bay.

In October several hauls were made in Aberdeen Bay by the "Star of Hope" and "St. Andrew," the cod-end, as before, being enveloped in fine-meshed netting. On the 8th a haul by the "Star of Hope" for 1

* "Scand. Fishes," i., 508. † See page 283.

hour and 55 minutes in from 12 to 14 fathoms yielded 2902 whitings (Pl. X.), the measurements of which arrange themselves as follows in centimetre groups:—

5	6	7	8	9	10	11	12	13	14	15	16	17
0	1	41	70	101	266	547	652	380	123	31	7	4
18	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
10	12	27	80	152	141	135	81	25	12	3	1	0

Two well-marked groups were present. The first comprised 2223 fishes from 69mm. to 173mm. in length, with a range, therefore, of 104mm., and an average size of 119·5mm. or $4\frac{11}{16}$ inches. The second group numbered 679, ranging in length from 183 to 297 mm., or a difference of 114mm., and with an average size of 233·1mm., or $9\frac{3}{16}$ inches. A year's growth, represented by the difference between the averages of the two groups, is shown in this case to amount to 113·6mm. or about $4\frac{1}{2}$ inches.

In another similar haul by the "Star of Hope" on 13th October, which lasted for an hour, and was made in from 8 to 18 fathoms, 713 whitings were taken. Their measurements arranged in centimetre groups are as follows:—

6	7	8	9	10	11	12	13	14	15
0	2	5	7	10	20	58	73	64	29
16	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
8	1	1	0	7	12	38	80	86	74
26	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**
52	41	19	9	6	6	1	1	1	2

Three annual series or generations are here represented. The first comprised 278 fish, from 72 to 185 mm. in length, with a difference of 113mm. between the smallest and the largest, and gave an average size of 133·7mm. or $5\frac{5}{16}$ inches. The five largest measured respectively 166, 167, 169, 178, and 185 mm., and it is possible the two latter belong to the next series. In that case the average for the remaining 276 fishes would be 132·8mm. The next series, if the two fish referred to be excluded from it, begins at 205mm., but it is not quite so clear where it

ends. The ·5cm. grouping shows a regular decline to 310mm., and then a slight rise; the millimetre groups indicate that the division may be about 295mm., there being a break from 292 to 296mm. On the latter basis the number of fish in the series would be 414, the range of size would run to 292mm., and the average size for the group would be 247·4mm. or 9¾ inches, and this is probably the correct division. If extended to 310mm., the average would be 249·3mm. or 9 13/16 inches for 423 fishes.

The averages for these two series in this haul are thus somewhat larger than in the haul of 8th October above described, in the first series by 14·2mm., and in the second by 14·3mm. These differences are much too large to be accounted for by the growth of the fishes in the interval between the two hauls, and are probably explained by the extension of the haul into deeper water. The increment of annual growth, however, from the one series to the other is almost precisely similar in the two cases, viz., 113·6 and 113·7 mm., or, if the group be extended to 310mm., as mentioned above, 115·6mm.

The third series in this haul was represented by 25 fish, the largest of which was 357mm.

In an hour's haul made by the "St. Andrew" on 31st October, in from 8 to 10 fathoms, the number of whitings taken was 3777 (Pl. X.). The centimetre grouping of the measurements is as follows:—

5	6	7	8	9	10	11	12	13
0	2	23	30	93	280	745	970	809
14	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**
487	178	46	24	10	5	8	12	12
23	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**
21	11	6	4	0	0	1	0	0

Two series are well represented in this haul. The first, consisting of 3702 whitings, range in size from 60mm. to 196mm., with a difference between the smallest and largest of 136mm., or 5⅜ inches. The average for the group is 126·7mm., or about 5 inches. The end of the series is pretty clearly indicated, there being an interval of ·5cm. between the one at 196mm. and the next at 202.

The second series is much smaller. It contains 75 fishes from 202 to 275 mm., with a range of 73mm. and an average size of 229·2mm., or slightly over 9 inches.

The apparent annual increment of growth between the two series is 102·5mm., or about 11mm. less than in the previous hauls. This is no doubt due to the small number of fishes represented in the second series.

If the average of the first series in this haul is compared with those of

the previous hauls, it will be seen that it is 7·0mm. less than for the haul of 13th October, and 7·2mm. more than for the haul of 8th October. Reasons have been given above which probably account for the high averages on 13th October, and the number of fishes in the first series on that occasion was small, viz., 278. The hauls of 8th and 31st October may, however, be regarded as suitable for comparison, since they were made in approximately the same depth of water, and the number of whitings in each case was large, viz., 2223 and 3702 respectively. The difference of 7·2mm. between the averages may therefore be taken as the amount of growth in the interval of 23 days, which represents an increase of ·3130mm. per day.

For the reasons above stated comparison of the averages of the second series cannot well be made.

Whitings captured in September and October in Aberdeen Bay by the "Garland's" shrimp-net with ¼ inch meshes were also measured. A night haul on 20th September, in 4 to 5½ fathoms, less than a mile from the shore, and parallel with it, yielded 349 specimens, the lengths of which are shown in centimetre groups thus:—

7	8	9	10	11	12	13	14
0	4	24	75	107	71	27	8
15	**16**	**17**	**18**	**19**	**20**	**21**	**22**
1	0	0	0	0	0	6	3
23	**24**	**25**	**26**	**27**	**28**	**29**	**30**
4	10	1	3	1	2	2	0

The first of the two series comprised 317 fishes, from 82 to 158 mm., the range being 76mm., and with an average size of 115·2mm. or $4\frac{9}{16}$ inches. The second series contained only 32 fishes, ranging from 212 to 298 mm., and with an average size of 239·1mm., or $9\frac{7}{16}$ inches. The difference between the averages was 123·9mm., or $4\frac{7}{8}$ inches, which represents the apparent year's growth in this case.

In another haul on 9th October, in from 13 to 16 fathoms, about two miles from shore, 238 whitings were taken, represented thus in centimetre groups:—

5	6	7	8	9	10	11	12
0	4	8	4	14	39	59	55
13	**14**	**15**	**16**	**17**	**18**	**19**	**20**
38	10	0	0	0	0	0	0
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**
0	2	2	0	2	1	0	0

Four measured 62, 63, 65, and 65 mm., the next largest being 70mm. in length.

The first series, well represented, contained 231 whitings, from 62 to 149 mm., with a range of 87mm., and an average size of 115·9mm., or 0·7mm. above the corresponding average of the previous haul nineteen days before. The second series was represented only by seven fishes varying from 220 to 263 mm., with an average of 240·7mm. The number is too small to make the average trustworthy; still it is only 1·6mm. above that of 20th September; and the two averages of this haul show an apparent annual increment of growth of 124·8mm., or almost the same as in the previous haul.

Another haul of the "Garland" on 23rd October, in 36½–49 fathoms, yielded 86 whitings, which fall into centimetre groups as follows:—

5	6	7	8	9	10	11	12
0	3	5	4	5	11	19	15
13	**14**	**15**	**16**	**17**	**18**	**19**	**20**
13	5	0	2	0	0	0	0
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**
0	0	3	0	0	1	0	0

Three of these measured 62, 64, and 65 mm., the next being 70mm.

The first series, well represented, comprised 82 whitings, from 62 to 169 mm. long, with a range of 107mm., and an average size of 114·1mm.,

or 1·8mm. less than the corresponding average on 9th October. The second series was represented by only four specimens, from 234 to 264 mm., but they furnish an average approximately equal to the previous cases, viz., 242·5mm., and an apparent annual increment of 128·4mm.

On comparing the averages in these three hauls of the "Garland," made in different depths of water, with one another, and with those derived from the hauls of the "Star of Hope" and "St. Andrew," the following facts appear. Those of the second series, although deduced from very small numbers of fish, show slight progressive increases, equivalent to 3·4mm. in the 33 days between the first haul and the third; and they are somewhat higher than the corresponding averages of the hauls by the trawlers. Those of the first series, on the other hand, while agreeing with one another pretty closely, varying only by 1·8mm., are considerably lower than the averages from the trawlers. In consequence of both these deviations the average annual increments of growth deduced from the "Garland" measurements, while also pretty closely agreeing with one another, the maximum deviation being 4·5mm.. are somewhat higher than in the case of the trawlers. It is not clear why the second series in the "Garland" catches should be larger than in those of the trawlers; but the smaller average for the first series is no doubt due in great measure to the smaller meshes of the shrimp-trawl used. It must also be borne in mind that the numbers of fishes dealt with in these cases are much smaller.

In December a number of hauls were made by the "Star of Hope" in Aberdeen Bay, on the same grounds and with the same nets as in October. On 17th December, in a haul for 1½ hours, in from 8 or 9 to 15 fathoms, 1397 whitings were taken, which are arranged in centimetre groups in the following Table:—

8	**9**	**10**	**11**	**12**	**13**	**14**	**15**
0	3	8	62	199	440	311	186
16	**17**	**18**	**19**	**20**	**21**	**22**	**23**
79	19	6	4	3	8	10	11
24	**25**	**26**	**27**	**28**	**29**	**30**	**31**
16	16	3	8	3	1	0	1

The first series includes 1315 whitings from 94 to 195 mm., with a range of 101mm., and an average size of 139·5mm., or 5½ inches. The second series comprises 81 from 197 to 294 mm., with a range of 97mm., and an average size of 243·2mm., or $9\frac{9}{16}$ inches. The apparent amount of growth in a year between the two generations is 103·7mm. There is another whiting 312mm. in length, which may belong to a third series; but it might also fall within the second series, in which case the range of

the latter would be extended to 115mm., the average increased to 244·0mm., and the annual increment to 104·5mm.

On 18th December another haul in 8 to 9 fathoms yielded 666 whitings, whose measurements are grouped in centimetres as follows:—

7	8	9	10	11	12	13
0	6	40	77	179	190	113
14	**15**	**16**	**17**	**18**	**19**	**20**
44	6	4	6	1	0	0

Only one series was represented, the range being from 82 to 186 mm., with a low average size of 121·3mm., or $4\frac{3}{4}$ inches.

Two hauls were made on 19th December. The first, for one and a half hours, was in from 6 to $8\frac{1}{2}$ fathoms, and 554 whitings were caught, which are thus arranged in centimetre groups:—

6	7	8	9	10	11
0	2	12	41	72	109
12	**13**	**14**	**15**	**16**	**17**
142	119	35	17	4	1

The two smallest of these measured 77 and 78 mm. The only series fully represented is one ranging in length from 77 to 177 mm., and having an average size of 123·4mm. or $4\frac{7}{8}$ inches. The low average in this haul, and in the haul on the day before, was perhaps partly due to the comparatively shallow water in which they were made, the smaller fish approaching closer to the shore than those of somewhat larger size. Thus the average size of the series in the haul on 17th December, which extended into 15 fathoms, was 139·5mm., and the second haul on the 19th also gave a high average for this series. It was made for $3\frac{1}{4}$ hours, part of the time in 5 fathoms, but mostly in from 9 to 12 fathoms, and the quantity of small fish caught was so great that the fine-meshed net was ruptured in bringing it on board. The number of whitings obtained was 8712, of which 3454 were measured and tabulated. They are shown in centimetre groups thus:—

6	7	8	9	10	11	12	13
0	1	11	18	76	230	726	946
14	**15**	**16**	**17**	**18**	**19**	**20**	**21**
777	418	166	39	12	4	4	3
22	**23**	**24**	**25**	**26**	**27**	**28**	**29**
3	13	3	1	1	2	0	0

Two series are here represented. The first comprised 3424 fishes (Pl. X.), varying in length from 78 to 196 mm., with a range of 118mm. or $4\frac{5}{8}$ inches between the smallest and the largest, and having an average size of 136·9mm., or slightly over $5\frac{3}{8}$ inches. The second series contained only 30 whitings, from 202 to 273 mm., and with an average size of 232·7mm., or $9\frac{3}{16}$ inches. The apparent yearly increment of growth between the two generations in this case is 95·8mm., or $3\frac{3}{4}$ inches.

On 21st December another haul was made by the "Star of Hope," in from 7–9 fathoms for an hour and a half, and 2117 whitings were captured, which are arranged as follows in centimetre groups:—

7	8	9	10	11	12
0	1	6	23	209	589
13	**14**	**15**	**16**	**17**	**18**
657	402	132	52	16	6
19	**20**	**21**	**22**	**23**	**24**
7	0	5	5	3	4

The first series contained 2100 fishes, ranging in size from 87 to 197 mm., with a difference between the smallest and the largest of 110mm., or nearly $4\frac{3}{8}$ inches, and having an average size of 133·8mm., or nearly $5\frac{5}{16}$ inches. The second series was represented by only 17 whitings, from 214 to 248 mm. in length, and with an average size of 229·1mm., or about

$9\frac{1}{16}$ inches, which is manifestly too low to indicate the real average of this series. The difference between the average of the two series in this case is 95·3mm., or about $3\frac{3}{4}$ inches, which is also too small to represent the annual increment of growth.

The variation of the average size of the whitings in these December hauls is considerable. In the first series the average varies from 123·4 to 139·5mm., a difference of 16·1mm.; and it is due partly to the hauls having been made at different depths, and partly to the varying number of fish taken. When the numbers are large, as on December 17th and 21st and the second haul on 19th, the averages approximate, differing by only 5·7mm. Those made at nearly the same depth on 17th and 19th December, namely, 8 to 15 fathoms and 5 to 12 fathoms respectively, give averages differing by only 2·6mm., the higher being in the deeper water. Since, however, the interval between the first and last hauls was only four days the results may be combined in order to give a mean average which will more accurately represent the facts. In that case the 8059 whitings belonging to the first series, with a range of size between 77 and 197 mm., or a difference between the smallest and the largest of 120mm., or $4\frac{3}{4}$ inches, give an average size of 134·2mm., or slightly over $5\frac{1}{4}$ inches. The fishes of the second series when combined in the same way number only 128, ranging from 197 to 294 mm. in length, with an average size of 239·0mm., or very slightly over 9 inches. The difference between the averages of the two series indicates an apparent annual growth of 104·8mm., or $4\frac{1}{8}$ inches. This is below the amount obtained from comparison of the October averages, and the reason appears to be principally because the number of fishes in the second series is much smaller in December. The three hauls in October produced 6203 belonging to the first series and 1168 belonging to the second series. The latter thus formed nearly 16 per cent. of the gross catch. In the December hauls the fish of the second series formed only $1\frac{1}{2}$ per cent. of the total catch; and this reduction in their numbers is no doubt owing to the larger fishes leaving the inshore waters, as the temperature falls, sooner than the younger fishes do. The average for the second series in October therefore more accurately represents the size of that series, and consequently the annual increment of growth for that month is more reliable.

If the results of the three hauls in October are similarly combined, then we have for the first series, comprising 6203 whitings, a range of size from 60 to 196 mm., with a difference of 136mm., or $5\frac{3}{8}$ inches, and having an average size for the series of 124·4mm., or $4\frac{7}{8}$ inches. For the second series, containing 1168 fishes, with a range from 183 to 297 mm., we get an average size of 237·9mm., or $9\frac{3}{8}$ inches. The difference between the two averages, or the apparent yearly increase of growth, in this case is 113·5mm., or very nearly $4\frac{1}{2}$ inches. This may, I think, be regarded as the approximate amount of growth of the whiting at this stage in a year.

It is also possible to ascertain something of the rate of growth of the whitings by comparing the averages for October and December; but while the hauls in the latter month were made within four days of one another, the former are separated by intervals of five days between the first and the second, and eighteen days between the second and the third. If the mean be taken, then the interval between the October and December hauls is just about two months, and the increment deduced for the first series in this time is 9·8mm., which is at the rate of about 0·1580mm. per day. At this rate the annual increase would be only 57·7mm., or about half of what it really is. No doubt the rate of growth is considerably reduced in colder weather.

(2.) Hauls in Deep Water.

Several hauls were made by the trawler "St. Andrew," with the cod-end of the otter-trawl enveloped as before with fine-meshed netting, in deep water offshore in August, September, and October. In the haul on 31st August in 62 fathoms, about 65 miles S.E. by E. of Sumburgh Head, Shetland, the number of whitings got in the fine-meshed net was ten. They all belonged to the first series, and ranged in size from 79 to 99 mm., having an average size of 92·1mm. The whitings caught in the ordinary trawl-net on this occasion were not measured. The observation is of interest in showing the presence of young whitings of the size mentioned on the deep-sea grounds, and their scarcity there.

In the haul on 4th September in the same locality, in 63 fathoms, 52 whitings were caught. Of these, 14 belonged to the first series, ranging in size from 79 to 118 mm., and having an average size of 99·1mm. The whiting of this series in the two hauls combined, 24 in number, gave an average size of 96·2mm., or about $3\frac{3}{4}$ inches. The other 38 whitings were measured to fractions of an inch. Of these, 33, ranging from $11\frac{1}{2}$ inches to $17\frac{3}{4}$ inches, or from about 292 to about 382 mm., gave an average size of $11\frac{3}{4}$ inches, or about 298mm. This group, it will be perceived, does not represent the second series of the hauls made later in Aberdeen Bay, which appears to be missing. The other five whitings belong to another series. They ranged in size from about 413 to about 451 mm., with an average of about 429mm., or $16\frac{7}{8}$ inches.

On the 16th October a haul of the "St. Andrew" with the small-meshed net in 65 fathoms, about 16 miles S.E. of Fair Isle, yielded 182 whitings, and another haul in the same locality on 19th October, in 60 fathoms, produced 199 whitings. They are arranged in centimetre groups on the first and second lines in the following Table. On the third line are placed the grouped measurements of the whitings taken in all other hauls by the "St. Andrew" in the deep water, between the 12th and the 20th October. These fish are entirely from the ordinary otter-net, *i.e*, without fine-meshed netting outside. On the fourth line the totals under each group are summed up, and the curve is shown on Plate XI.

[Table.

8	9	10	11	12	13	14	15	16	17	18	19
..	..	..	1	1	1	..	..	..	..	..	..
..	1	5	8	5	3	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..
..	1	5	9	6	4	..	..	..	..	..	..
20	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**
..	..	..	..	..	1	3	13	19	21	28	23
..	..	..	..	2	..	4	7	14	52	26	20
..	..	1	..	..	..	14	36	96	125	129	110
..	..	1	..	2	1	21	56	129	198	183	153
32	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**
19	17	8	6	8	2	1	2	..	1	..	..
22	12	4	5	4	2	1	1	..	..	1	..
78	69	34	27	15	12	8	7	7	2	5	1
119	98	46	38	27	16	10	10	7	3	6	1
44	**45**	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**	**55**
2	..	3	..	1	..	..	..	1	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..
3	2	1	4	2	2	..	..	..	3	1	..
5	2	4	4	3	2	..	..	1	3	1	..

In these hauls four series or generations are represented, and one is absent or almost absent. The whitings belonging to the first were all caught in the small-meshed net, 3 on 16th October 116, 125, and

130 mm. in length, and 22 on the 19th from 98 to 139 mm., with an average size of 116·5mm. The average for the 25 fishes is 117·4mm., or $4\frac{5}{8}$ inches. The average for the combined similar series on 31st August and 4th September was 96·2mm., so that if the lots were really representative of the series the growth in the 46 days or so between the hauls would be equivalent to the difference of 21·2mm. That would be at the rate of 0·4609mm. daily, which, on the assumption that growth continued uniform throughout the whole year, would add an increment of 168·2mm. annually. We know, however, that growth is retarded or arrested during winter, and the number of days required to attain the annual increment of 113·5mm., which was brought out by the averages for Aberdeen Bay (p. 174), would, on the basis indicated, be 247, or a little over eight months.

This series, so abundantly represented in the inshore waters, as Aberdeen Bay, at the same dates, was thus present in very small numbers in the deep water, at all events on the bottom. It is not impossible, however, that these few whitings were taken by the net as it was being set and hauled, and that the series is present at this stage in abundance at intermediate depths. It will be observed that the average is somewhat lower than the corresponding averages in October in Aberdeen Bay.

In the haul of 16th October there was no whiting between 130mm. and 257mm., and in that of 19th none between 139 and 242 mm., the gap in the former case being 127mm., or about 5 inches, and in the latter, 103mm., or $4\frac{1}{16}$ inches. It is clear, therefore, that the second series of the Aberdeen hauls was either absent in the deep water or more probably represented only by a few of the larger individuals in the hauls of 19th October and the combined hauls of the otter-trawl. In the haul of 19th October two whitings at 242 and 248 mm. appear to belong to the missing series, and in the combined hauls of the otter-trawl one at 220mm. also represents it. The feature in each case, as may be seen from the Table and the graphic curve (Pl. XI.), is a well-marked series beginning at about 25cm. and ending about 40cm. In the haul of 16th October there were 171 whiting in this group, from 257mm. to 395mm., with a range, therefore, of 138mm., or $5\frac{7}{16}$ inches, and an average size of 325·3mm., or $12\frac{3}{4}$ inches. In the haul of 19th October this series contains 174 fishes from 262mm. to 396mm., with a difference of 134mm., or a little over $5\frac{1}{4}$ inches, and an average size of 305·9mm., or 12 inches. In the measurements from the otter-trawl catches the range in this series is from 261mm. to 404mm., with a difference of 143mm., or $5\frac{5}{8}$ inches. The number of whitings in this group in the ordinary hauls was 765, and the average size was 312·6mm., or about $12\frac{3}{8}$ inches. If all the hauls are combined we get for this series,

No. of Fish,	Range of Size,	Difference,	Average Size,
1110.	257 to 404 mm.	147mm.	313·5mm.

The range of this series may therefore be regarded as about $5\frac{3}{4}$ inches, and the average size as about $12\frac{5}{16}$ inches. The difference between the average of this series and that of the first (117·4) amounts to 196·1mm., or about $7\frac{11}{16}$ inches, which would approximately represent the mean increment of growth in two years.

The remaining whitings represent two or more series or generations. The first commences about 40cm. and extends to 49cm. In the haul of 16th October it is represented by 7 fishes from 412mm. to 481mm., and with an average size of 453·3mm., or $17\frac{13}{16}$ inches. In the haul of 19th October there is only one of 422mm. In the combined *ordinary* hauls

there are 22 from 410 to 491 mm., with a considerably higher average—viz., 476·7mm., or 18¾ inches. When all hauls are combined the range of the 30 fishes is from 410 to 491 mm., with an average of 469·4mm., or very nearly 18½ inches. The difference between this average and that of the previous series is 155·9mm., or 6⅛ inches, which would represent the apparent increment of growth in a year. This is evidently too high, judging from the earlier annual increment, and it might be modified if the number of fishes were greater. On the other hand, it is not improbable that the larger fishes included in series D belong to the later series E. (p. 184), which cannot at present be very clearly differentiated from the former. The other series is represented by one fish, of 526mm., in the haul on 16th October, and by four in the combined ordinary hauls, the latter ranging from 531 to 541 mm. The average for the five fishes is 534·2mm., or 21 inches. The numbers of the two latter series are, however, too small and the separation insufficiently distinct to enable a trustworthy average to be obtained. The variation in the apparent annual increment of growth in the two cases shows that the division indicated, and the averages, are not the true ones. All that can be said with certainty is that there are at least two annual groups after the third or C series. To determine their real limits and the mean size will require a considerably greater number of observations.

(3.) Hauls in the Moray Firth.

Whitings caught in the Moray Firth by the "Star of Hope," "St. Andrew," and "Garland," in November, December, and January, were also measured. In a haul with the fine-meshed net by the "St. Andrew," on 6th November, in from 8 to 9 fathoms, between Lossiemouth and Tarbet Ness, 266 whitings were captured, and a similar haul two days later, in 35 fathoms, to the east of Smith Bank, yielded 238 fish. The measurements are arranged in centimetre groups as follows, the first line representing the haul on 6th, and the second line the haul on 8th November. It will be seen that the groups are very different in the two cases, the early series being absent in the deep-water haul, and the second series scarcely represented in the haul in the shallow waters.

[Table.

3	4	5	6	7	8	9	10	11
0	2	1	9	7	4	2	6	29
..	..	..	..	..	..	..	..	..
12	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
31	22	31	36	21	22	18	8	3
..	..	..	..	..	..	..	..	2
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**
5	1	4	1	..	1	..	..	2
7	16	34	44	55	32	21	13	5
30	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**
..	..	..	..	..	..	..	..	..
4	3	1	..	..	..	..	1	..

The haul on the 6th November is interesting as including some very small whitings ranging from 45mm., or a little more than 1¾ inches, to 79mm., and over. This group is indicated in the above Table, but their relation to those somewhat larger is better shown by the 2mm. grouping on page 187. They appear to represent the smaller individuals of the same year's brood, the problem in regard to which is dealt with below.

The first series in this haul, which were measured by Mr. Dannevig, comprises 249 whitings from 45 to 198 mm., with a range of 153mm. and an average size of 140·1mm., or 5½ inches. This is higher than the average of the corresponding series at Aberdeen Bay (*see* p. 182), the highest October average there being 133·7mm., and the highest December average 139·5mm. One reason for the disparity seems to be the absence of a normal proportion of fish between 12 and 14 cm., so that the curve is quite peculiar. The range in size of the specimens is also abnormally great, and it appears probable that, if the smaller individuals belong to the series, the division is not exactly represented.

The next series is indicated by 17 fishes from 203mm. to 298mm., corresponding to the series so well represented in the offshore haul of 8th November. The average size of these 17 fishes was 233·1mm., or $9\frac{3}{16}$ inches, which is rather below the average of the corresponding series in Aberdeen Bay.

As already stated, the haul of 8th November in 35 fathoms contained no fish belonging to the early series, and it thus resembled the hauls in the deep water, when only a few were present. Of the 238 whitings caught, 237 ranged in size from 200mm. to 328mm., and one measured 372mm. The centimetre curve, however, shows a continuous and rapid drop from 25cm. to 29cm., and a very gradual fall thereafter to 33cm., and it is probable the series terminates at 292mm., the remainder representing another group of which the fish at 372mm. is a member. On this basis the range would be 92mm., and the average size of the 226 fishes included would be 250·8mm., or $9\frac{7}{8}$ inches, slightly higher (by 3·4mm.) than the highest corresponding average for Aberdeen Bay in October. If the whole of the fishes up to 328mm. are included, the range becomes 128mm. and the average size 253·5mm., or very nearly 10 inches.

A haul made on 25th December by the "Star of Hope" in 12 fathoms in the Dornoch Firth may be contrasted with the two hauls of the "St. Andrew" in November, just described. The measurements, which were made by myself, furnish a complete curve of the series imperfectly represented in the haul on 6th November, and absent from the haul on 8th November. The measurements of the 318 whitings are arranged in centimetre groups as follows:—

8	9	10	11	12	13	14	15
3	10	5	36	58	70	45	38
16	**17**	**18**	**19**	**20**	**21**	**22**	**23**
17	7	6	2	..	3	1	3
24	**25**	**26**	**27**	**28**	**29**	**30**	**31**
2	2	3	2	3	1	1	..

The smallest fishes in this case, as in the last, appear to be somewhat separated from the remainder. In ·5cm. groups they are disposed as follows:—

cm.	8	8·5	9	9·5	10	10·5	11	
	0	3	4	6	3	2	13	&c.

The grouping in 2mm. groups is also indicated in the table given on page 187.

The 297 whitings from 87 to 193mm. form a well-marked group, with a range of 106mm., and an average size of 134·8mm., or $5\frac{5}{16}$ inches. This is 0·6mm. above the mean for the corresponding series in Aberdeen Bay in December; but it is exceeded by two of these averages—viz., 139·5 of 17th and 136·9 of 18th December. It would have been

interesting to compare the average of this group with the corresponding average for the haul on 6th November, 49 days earlier; but owing to the imperfection of the latter, as described above, the comparison would not be trustworthy. But if the average size of this series be compared with the average size of the next series or generation in the haul of 8th November, it will be found that the difference is 116·0mm. This would represent the increment of growth in a year, plus the 47 days between 8th November and 25th December, and it agrees fairly well with the annual increment deduced for Aberdeen Bay in October —viz., 113·5mm.

The next series was represented by 21 whitings from 211 to 300 mm., with a range of 89mm. and an average size of 255·5mm., or $10\frac{1}{16}$ inches. This is 4·7mm. higher than the corresponding average in November (*supra*), but the number of fishes in this case is small.

Hauls were made by the small shrimp net of the "Garland" in the Moray Firth in December and January, which may be contrasted with those above described. The measurements are set forth in centimetre grouping in the following Table. A haul on 5th December in 12 to 14

Date.	6	7	8	9	10	11	12	13
Dec. 5	..	1	1	3	7	9	10	5
„ 11	..	..	..	1	2	2	4	5
„ 11*	..	1	..	1	3	2	5	4
„ 24	..	1	3	3	11	11	16	12
Jan. 10	..	..	..	2	4	7	8	9

Date.	14	15	16	17	18	19	20	21
Dec. 5	2	..	..	..	..	..	..	..
„ 11	3	1	1	..	..	..	..	..
„ 11*	2	1	..	..	..	..	..	..
„ 24	4	3	1	..	..	1	..	..
Jan. 10	5	3	1	2	..	..	..	..

*12 fathoms, outside Souters.

fathoms in the Dornoch Firth yielded 38 whitings from 75mm. to 148mm., the average size, being 116·1mm. or about $4\frac{9}{16}$ inches. One on 11th December, in 8 to 12 fathoms, also in the Dornoch Firth, produced 19 whitings from 98 to 165 mm., and with an average size of 129·2mm. One on the same day, in 12 fathoms outside Cromarty Firth, produced 19 whitings from 75 to 150mm., the average size being

121·6mm. or $4\frac{3}{16}$ inches. Another on 24th December in 10 fathoms in the Dornoch Firth yielded 66 whitings, from 76 to 191 mm., with an average size of 121·6mm. A haul on 10th January, 1901, in $6\frac{1}{2}$ to 8 fathoms in Cromarty Firth, produced 41 whitings from 92 to 175 mm., with an average size of 129·7mm. The averages, it will be perceived, vary considerably in December, from 116·1mm. on 5th to 129·2mm. in one of the hauls on the 11th; the mean of the two hauls on that day is, for the 37 fishes, 126·5mm. The mean size of the 139 fish of the series caught in all the December hauls of the "Garland" is 122·0mm., or $4\frac{3}{16}$ inches. The October averages for the same net in Aberdeen Bay were 115·2, 115·9, and 114·1 mm. I append a Table giving particulars of the series into which the 18,466 whitings that were measured are divided according to the hauls.

Date.	Depth.	No. of Fish.	Size.				Apparent Annual Growth.	
			Range.	Difference.	Average.			
Aberdeen Bay.	Fms.		Mm.	Mm.	Mm.	Inches.	Mm.	Inches.
8 *Oct.*	12-14							
A Series . .		2223	69-173	104	119·5	$4\frac{11}{16}$	...	...
B ,, . .		679	183-297	114	233·1	$9\frac{3}{16}$	*113·6*	$4\frac{7}{16}$
13 *Oct.*	8-18							
A Series . .		278	72-185	113	133·7	$5\frac{5}{16}$	...	...
B ,, . .		414	205-292	87	247·4	$9\frac{3}{4}$	*113·7*	$4\frac{7}{16}$
Average 8th and 13th.								
A Series . .		*2501*	*69-185*	*116*	*121·0*	$4\frac{3}{4}$	...	...
B ,, . .		*1093*	*183-297*	*114*	*238·5*	$9\frac{3}{8}$	*117·5*	$4\frac{5}{8}$
31 *Oct.*	8-10							
A Series . .		3702	60-196	136	126·7	5	...	...
B ,, . .		75	202-275	73	229·2	$9\frac{1}{16}$	*102·5*	$4\frac{1}{32}$
Average of October.								
A Series . .		*6203*	*60-196*	*136*	*124·4*	$4\frac{7}{8}$	...	...
B ,, . .		*1168*	*183-297*	*114*	*237·9*	$9\frac{3}{8}$	*113·5*	$4\frac{1}{2}$

Date.	Depth.	No. of Fish.	Size.				Apparent Annual Growth.	
			Range.	Difference.	Average.			
ABERDEEN BAY—*continued.*	Fms.		Mm.	Mm.	Mm.	Inches.	Mm.	Inches.
20 *Sept.*	4–5½							
A Series . .		317	82-158	76	115·2	4 9/16	...	...
B ,, . .		32	212-298	86	239·1	9 7/16	*123·9*	*4 7/8*
9 *Oct.*	13–16							
A Series . .		231	62-149	87	115·9	4 9/16	...	...
B ,, . .		7	220-263	43	240·7	9½	*124·8*	*4 11/16*
23 *Oct.*								
A Series . .	36½–49	81	62-169	107	114·1	4½	...	...
B ,, . .		4	234-264	30	242·5	9 9/16	*128·4*	*5 1/16*
17 *Dec.*	8–15							
A Series . .		1315	94-195	101	139·5	5½	...	...
B ,, . .		81	197-294	97	243·2	9 9/16	*103·7*	*4 1/16*
18 *Dec.*	8–9							
A Series . .		666	82-186	104	121·3	4¾	...	...
19 *Dec.*	6-8½							
A Series . .		554	77-177	100	123·4	4 7/8	...	...
19 *Dec.*	5–12							
A Series . .		3424	78-196	118	136·9	5⅜	...	...
B ,, . .		30	202-273	71	232·7	9 3/16	*95·8*	*3 13/16*
21 *Dec.*	7–9							
A Series . .		2100	87-197	110	133·8	5 5/16	...	...
B ,, . .		17	214-248	34	229·1	9 1/16	*95·3*	*3¾*
Average Dec.								
A Series . .		*3059*	*77-197*	*120*	*134·2*	*5¼*	...	...
B ,, . .		*128*	*197-294*	*97*	*239·0*	*9*	*104·8*	*4 1/8*
Deep Water.								
31 *Aug.*	62							
A Series . .		10	79-99	20	92·1	3⅝	...	...
4 *Sept.*	63							
A Series . .		14	79-118	39	99·1	3⅞	...	...
*C ,, . .		33	292-382	92	298·	11¾	*198·9*	*7 13/16*
*D ,, . .		5	413-451	38	429·	16⅞	*131·0*	*5 5/16*
Average A Series		*24*	*79-118*	*39*	*96·2*	*3 13/16*	...	...

* Measured in fractions of inch

Date.	Depth.	No. of Fish.	Size.				Apparent Annual Growth.	
			Range.	Difference.	Average.			
DEEP WATER—*continued.*	Fms.		Mm	Mm.	Mm.	Inches.	Mm.	Inches.
16 *Oct.*								
A Series . .		3	116-130	14	123·7	4⅞	...	...
C ,, . . .		171	257-395	138	325·3	12 13/16	*201·6*	*7 15/16*
D ,, . .		7	412-481	69	453·3	17 11/16	*128·*	*5*
E . . .		1	526	...	526	20 11/16	...	...
19 *Oct.*								
A Series . .		22	98-139	41	116·5	4 9/16	...	...
*C ,, . .		174	262-396	134	305·9	12	*189·4*	*7 7/16*
D ,, . .		1	422	...	422	...	...	...
12–20 *Oct.*								
OTTER TRAWL.								
C Series . .		765	261-404	143	312·6	12⅜	...	...
D ,, . .		22	410-491	81	476·7	18¾	*164·1*	*6 7/16*
E . . .		4	531-541	10	536·2	21⅛	...	...
Average October.								
A Series . .		*25*	*98-139*	*41*	*117·4*	*4⅝*	...	...
B , . . .		...	...	...	...	...	...	...
C , . . .		*1110*	*257-404*	*147*	*313·5*	*12 5/16*	*196·1*	*7 11/16*
D . .		*30*	*410-491*	*81*	*469·4*	*18½*	[*155·9*	*6⅛*]
E ,, . . .		*5*	*526-541*	*15*	*534·2*	*21*	[*64·8*	*2 9/16*]
Moray Firth.								
6 *Nov.*	8–9							
A Series . .		249	45-198	153	140·1	5½	...	...
B ,, . .		17	203-298	95	233·1	9 3/16	*93·0*	*3 11/16*
8 *Nov.*	35							
C Series . .		[237	200-328	128	253·5	9 15/16]	...	...
		226	200-292	92	250·8	9⅞	...	...
25 *Dec.*	12							
A Series . .		297	87-193	106	134·8	5 5/16	...	...
B ,, . .		21	211-300	89	255·5	10 1/16	*120·7*	*4¾*

* Measured in fractions of inches

Date.	Depth.	No. of Fish.	Size.				Apparent Annual Growth.	
			Range.	Difference.	Average.			
Moray Firth—*continued.*	Fms.		Mm.	Mm.	Mm.	Inches.	Mm.	Inches.
5 *Dec.*								
A Series . .	12–14	38	75-148	73	116·1	$4\frac{9}{16}$	...	...
11 *Dec.*								
A Series . .	8–12	19	98-165	67	129·2	$5\frac{1}{16}$	...	...
A ,, . .	12	19	75-150	75	121·6	$4\frac{13}{16}$	...	..
24 *Dec.*	10							
A Series . .		66	76-191	108	121·6	$4\frac{13}{16}$	...	...
10 *Jan.*								
A Series . .	$6\frac{1}{2}$–8	41	92-175	83	129·7	$5\frac{1}{8}$	...	...
Average Dec.								
A Series . .		*139*	*83-191*	*108*	*122·0*	$4\frac{13}{16}$	...	...

SUMMARY.

The differentiation of most of the groups or series above described is, I think, fairly complete and satisfactory. It is, however, necessary to consider the position of the first or A series in relation to the spawning time, *i.e.*, whether the fish comprised within it are fish of the year, about six or seven months old in October and December, or whether they belong to the previous year, on the assumption that the season's brood had for the most part escaped capture. It has been usually supposed that the small whitings which frequent the inshore waters in autumn were spawned in the spring of the same year. In 1890, in describing the appearance in the Firth of Forth in September of immense numbers of young whitings, mostly ranging in size from three to five inches, but some of which were two inches in length, I expressed the opinion that they were mostly fish of the previous year, but recruited by those spawned from three to six months before.* Mr. J. T. Cunningham has expressed the belief that whitings from 73 to 126 mm. in length taken on September 9th are from three to six months old, and that those described by myself were hatched in the preceding April and May. Specimens taken at the end of January, from 4 to $5\frac{7}{8}$ inches (102–149 mm.) in length, he considers were spawned about nine months before. Others from 6 to $7\frac{1}{2}$ inches (152–190 mm.), taken at the same time, he considers, but with some doubt, to be probably eleven months old. Others at $8\frac{1}{4}$ inches (210mm.) caught in February he believes to be two years old.†

* *Eighth Annual Report Fishery Board for Scotland*, Part iii., p. 175.

† *Journ. Marine Biol. Assoc.*, N.S., ii., pp. 108, 358, 1891, 1892.

Professor M'Intosh* has expressed the opinion that whitings may reach a length of 6¾ inches (172mm.) in the November of the year in which they were spawned, and a length of 8¾ inches (222mm) in the following February, *i.e.*, before attaining one year of age. According to this view the whiting may become mature when one year old, since maturity is reached at a length of 9 inches and the spawning period extends to the end of June or later. According to my observations the whiting spawns in March, April, May, and June; some ripe fishes were taken in July, and one early in August.† Holt‡ states that it spawns in the North Sea from the beginning of March to the early part of June, and chiefly in April. Masterman§ describes the eggs of the whiting as having been taken in the Firth of Forth from 22nd February to 22nd July (comprising a series of years), a period of five months. Williamson‖ found eggs from 14th March to 4th June in the year 1895; they were very common during April and May. It is thus evident that the spawning period is a long one, and the height of the spawning appears to be towards the end of April. At the mean temperature then prevailing in the surface waters the eggs of the whiting, according to the experiments of Mr. H. Dannevig,¶ would take about ten or twelve days to hatch, and it is therefore in all probability to the end of April and the early part of May that we must attribute the birth of the larval whitings which form the majority of the year's brood, and whose average size I have given in successive series above.

From the Table it will be seen that the series (A) which characteristically represents the shoals of young whitings that frequent the inshore waters in autumn, had an average size on 20th September (317 fishes) of 115·2mm. or 4 9/16 inches, and in October (6203 fishes) of 124·4mm. or 4⅞ inches, and that in the latter month the extreme range was from 2⅜ inches to 7 1/16 inches. It will also be found that the difference between the averages of the successive annual groups or generations A and B varies from 3¾ inches to 5 1/16 inches, the mean for the twelve cases in which the comparison can be made being 110·7mm. or nearly 4⅜ inches, and that for the best cases, in which both series are most fully represented, viz., October, 113·5mm. or 4½ inches. This represents the mean increase in the length of the adolescent whiting in the course of a whole year, and taken by itself it might at first appear to suggest that the larval and post-larval whiting could scarcely grow so as to reach an average length of 4⅞ inches in the five and a half months from the end of April to the middle of October. The evidence from the amount of growth of the same series at different periods is also suggestive. Thus the average size of the 6203 whitings of the series was 124·4mm. or 4⅞ inches in October; in December it was (for 8059 whitings) 134·2mm. or 5¼ inches, showing an average increase in about two months of 9·8mm. or ⅜ of an inch. In summer the growth is, however, quicker.

As in the case of *Gadus esmarkii*, there is no doubt that the smaller specimens escape capture by the fine-meshed trawl employed, especially in hauls made in the summer before the fish have attained any considerable size. This circumstance is, however, due not merely to the size of the meshes of the net being too small to retain them, but also, as pointed out in 1890, to their absence from the grounds frequented by those somewhat larger. Many small specimens of the series, however, have been taken in the tow-nets of the "Garland" during the summer, and

* *Fifteenth Annual Report Fishery Board for Scotland.* Part iii., p. 204, 1897.

† *Tenth Annual Report Fishery Board for Scotland*, Part iii., p. 234, 1890.

‡ *Journ. M. B. Assoc.*, ii., 385, 1892.

§ *Fifteenth Annual Report Fishery Board for Scotland*, Part iii., p. 227, 1897.

‖ *Ibid.*, *Thirteenth Report*, Part iii., p. 258, 1895.

¶ *Ibid.* 149.

described by Professor M'Intosh, and Messrs Williamson, Kyle, and Masterman. On 30th and 31st July six were obtained in the Moray Firth, measuring from 17 to 30 mm.; on 21st June two were taken, each 22mm. long; on 24th August one at only 5·4mm. was got; on 29th August four caught in the Firth of Forth measured 24, 26, and 59 mm.; on 25th July, at Orkney, one of 42mm. was captured; a series were obtained in the Moray Firth on 9th August, from 22 to 65 mm. in length; on 1st October one was caught in the Firth of Forth which measured 19mm.* On 3rd October last four whiting, measuring 41, 47, 70, and 72 mm. were got in mid-water in Aberdeen Bay, where the depth was 15 fathoms, and on the 6th October another of 56mm. was secured in 8 fathoms where the water was 9 fathoms deep. It may also be stated here that gadoids, the species of which were not distinguished by the authors above named, were obtained in June, measuring from 3 to 17 mm.; in July from 2·25 to 5 mm., in August 12mm., and in October 9mm., and many of these were doubtless whitings.

The smaller whitings obtained by me in the trawl in autumn and winter are given in the following Table according to their measurement in 2mm. grouping.

It is evident from this Table and the particulars given of the tow-net collections that the sizes of the fishes taken are very different in the two cases, and here, as with *Gadus esmarkii*, it might be suggested that they represent two separate series, the smaller being the brood of the year while the larger, comprised in series A, represent the fish of the year before. It is indeed the case that in some of the hauls with the fine-

Date.	61	63	65	67	69	71	73	75	77	79	81	83	85	87	89	91	93	95	97	99	101	103	105
Aug. 31	.	.	.	.	.	.	.	.	.	1	1	.	1	.	.		.	3	.	4	.	.	.
Sept. 4	.	.	.	.	.	.	.	.	.	1	1	2	.	.	.	.	1	.	1	.		1	1
Oct. 8	.	.	.	.	1	6	6	13	11	5	14	12	14	19	11	13	18	23	23	26	30	47	59
,, 9	.	2	2	.	.	1	3	1	2	1	1	1	1	1	.	2	2	3	4	3	3	8	10
,, 13	.	.	.	.	.	.	1	.	.	1	1	1	1	.	2	1	2	3	.	1	.	1	2
,, 23	.	1	2	.	.	1	1	1	1	1	.	.	2	2	.	.	1	2	1	1	3	2	4
,, 31	1	.	.	1	.	1	6	5	7	4	6	5	6	6	7	12	18	20	21	22	29	42	61
Oct.	1	3	4	1	1	9	17	20	21	12	22	19	24	28	20	28	41	51	49	53	65	100	136
Nov. 6†	.	1	.	5	3	2	2	1	1	1	.	1	1	1	1	.	.	1	.	1	2	.	.
Dec. 5	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	1	1	1	3	1	.
,, 17	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1		.	1
,, 18	.	.	.	.		.	.	.	.	.	.	1	1	.	4	4	4	6	15	11	10	15	16
,, 19	.	.	.	.	.	.	.	.	.	1	.	.	5	2	4	6	5	1	4	1	10	11	13
,, 19	.	.	.	.	.	.	.	.	1	1	.	3	2	4	3	5	6	11	10	9	7	11	17
,, 21	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	1	2	2	2	5	2
,, 24	.	.	.	.	.	.	.	.	1	.	.	1	1	.	1	.	1	1	.	1	1	3	.
,, 25	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	3	1	1	2	3	.	1	3
Dec.	.	.	.	.	.	.	.	1	2	2	.	5	9	9	15	18	18	22	35	29	33	47	52

† Also one each at 45, 49, 57 mm.

* *Annual Reports of Fishery Board for Scotland*, Part iii., 10th, p. 307; 13th, p. 269 14th, pp. 224, 226; 15th, p. 258.

meshed bottom net the smallest specimens appear to form a more or less distinctly-marked initial group. In the haul of 6th November, for example, there were young whitings measuring 45, 49, 57, and 62 mm. and up to 79 mm. somewhat distinct from the rest, and this was also indicated in some of the hauls in October. It might be supposed that these are the largest individuals of the season's brood, beginning to leave mid-water and to approach the shore and descend to the bottom. But in other cases no such initial group can be detected. In the haul of October 8th, for instance, when over 2000 small whitings were taken, it is not present. The difference between the sizes of the fishes taken in the tow-nets and the bottom-net appears to be owing to the peculiarity in the action of the two apparatus, as well as to difference of habitat of the different stages. The smaller fishes escape through the meshes of the latter, while the larger dodge the tow-net and are not taken.

As I stated when dealing with *Gadus esmarkii*, the first series, A, must be regarded as the brood of the year. It indicates very rapid growth in the case of the whiting that some individuals should reach a length of between seven and eight inches in October, when they cannot be more than eight months old. At this time, however, the average length is under five inches, and this would be a small fish to have lived through two summers.

It will be noticed that, unlike what was found to obtain with *Gadus esmarkii*, the early series are not sharply separated from one another, but on the contrary blend to some extent; this is doubtless due in great measure to the prolonged spawning season. A whiting hatched early in March may be in the following autumn as large as one that was hatched in the previous July or August, which is overtaken by the winter's cold before it has made much progress in development. Another cause is the variation in the rate of growth of individuals born at the same time; some always grow faster than others. It may be presumed that *Gadus esmarkii* has comparatively a restricted spawning period. The conditions of its life in the deeper waters are also more uniform, especially with regard to temperature.

The various annual series or generations represented in the investigation may be grouped as follows, with their average size, range, and age in October, and the approximate annual increment of growth from the preceding series.

[TABLE.

		Size.		Approximate Age.		Apparent Growth in a Year from previous Series.	
		Mm.	Inches.	Yrs.	Mths.	Mm.	Inches.
A Series . . (6203 fish)	Smallest	69	$2\frac{11}{16}$	-	2	...	...
	Average	124·4	$4\frac{7}{8}$	-	$5\frac{1}{2}$	...	...
	Largest	196	$7\frac{11}{16}$	-	7	126	$4\frac{11}{16}$
B Series . . (1168 fish)	Smallest	183	$7\frac{1}{4}$	1	2	114·0	$4\frac{1}{2}$
	Average	237·9	$9\frac{3}{8}$	1	$5\frac{1}{2}$	113·5	$4\frac{1}{2}$
	Largest	297	$11\frac{11}{16}$	1	7	101	4
*C Series . . (1110 fish)	Smallest	257	$10\frac{1}{8}$	2	2	74	$2\frac{11}{16}$
	Average	313·5	$12\frac{5}{16}$	2	$5\frac{1}{2}$	75·6	3
	Largest	404	$15\frac{7}{8}$	2	7	107	$4\frac{5}{16}$
*D Series . . (30 fish)	Smallest	410	$16\frac{1}{8}$	3	2	[153	6
	Average	469·4	$18\frac{1}{2}$	3	$5\frac{1}{2}$	[155·9	$6\frac{1}{8}$]
	Largest	491	$19\frac{5}{16}$	3	7	[87	$3\frac{3}{8}$]
*E Series . . (5 Fish)	Smallest	526	$20\frac{11}{16}$	[4	2]	[116	$4\frac{5}{16}$]
	Average	534·2	21	[4	$5\frac{1}{2}$]	[64·8	$2\frac{5}{16}$]
	Largest	541	$21\frac{5}{16}$	[4	7]	[50	

* Deep-water hauls.

In considering this Table it must be borne in mind that the first three series represent hauls in Aberdeen Bay, and the last three represent hauls made more than a hundred miles northward in deep water, from which series B was absent (*see* p. 177). The series in the two regions may not correspond in growth, although the average for series B in deep water and in Aberdeen Bay agrees fairly well, the former being, however, somewhat lower (p. 184). The particulars for series A, B, and C are probably pretty accurate, and are based upon the measurements of large numbers of fish. Those for series D and E are based on very few fish, and they obviously do not represent the true relationship. A greater number of fish might possibly indicate three series within their limits. It is to be noted that the interval between the series A and the series E of the deep-water hauls is 417mm. or about $16\frac{2}{5}$ inches, and this would give a mean for each of four series intervening of almost exactly 4 inches.

As already stated, the average growth of the adolescent whiting is about $4\frac{1}{2}$ inches in a year, and since the minimum size of a mature female is 9 inches, it appears to be very probable that a few of them may spawn when about one year old, as we saw was the case with *Gadus esmarkii*, but to a much more limited extent. The largest individual of series A

in October, of an approximate age of seven or eight months, was 7$\frac{11}{16}$ inches long, and it would no doubt reach a length exceeding 9 inches before the following July. The smallest of the next series, on the other hand, was only 7$\frac{1}{4}$ inches when about one year and two months old, and the average-sized fish, representing of course the great bulk of the generation, was only 9$\frac{3}{8}$ inches long in October and almost certainly under the size of maturity during the preceding spawning season. All the fish in series C, from two years and two months to two years and seven months old, were above the minimum size of maturity in October, and the great majority of them must have spawned in the preceding spawning period; a few of the smallest, however, may not have done so. Thus a few whitings spawn in their first year, the great majority spawn first in their second year, and a few probably not until three years old. Moreover, some may spawn in four successive years, but the great majority cannot spawn in more than three seasons. The largest whiting obtained—about 21$\frac{1}{4}$ inches long—was nearly five or perhaps nearly six years of age.

THE HADDOCK (*Gadus æglefinus, L.*).

1. Hauls in Aberdeen Bay.

In a haul made on 8th October in 12–14 fathoms in Aberdeen Bay, with the cod-end of the otter-trawl enveloped in fine-meshed netting, the number of haddocks taken was 491; and another haul on the 13th October, in 8–18 fathoms, yielded 598. The measurements are arranged in centimetre groups as follows, the first line representing the first haul, the second line the second haul, and the third line the totals.

11	12	13	14	15	16	17	18	19	20
1	3	27	64	133	129	90	24	7	..
..	..	3	6	7	11	6	4	..	..
1	3	30	70	140	140	96	28	7	..
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
..	..	..	1	6	2	1	1	..	2
..	..	4	11	24	73	111	102	98	61
..	..	4	12	30	75	112	103	98	63

31	32	33	34	35	36	37	38	39	40
..	..	..	..	..	..	..	..	..	..
27	5	8	2	6	4	5	1	1	..
27	5	8	2	6	4	5	1	1	..
41	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**
..	..	..	..	..	..	..	..	..	..
..	1	..	..	..	..	..	..	1	..
..	1	..	..	..	..	..	..	1	..

Two groups are here very distinctly represented; their curves are well-marked and uniform (see Pl. XIII.). In the haul on October 8th the haddocks in the cod-end of the otter-trawl were not measured, and this haul therefore comprises almost exclusively the first series. The number of fish in this series was 478, varying from 118mm. ($4\frac{5}{8}$ inches) to 199 mm. ($7\frac{3}{16}$ inches), with a range, therefore, between the smallest and the largest of 81mm., or $3\frac{3}{16}$ inches. The average size was 159·7mm., or a little over $6\frac{1}{4}$ inches. For the reason stated above, the second series in this haul is inadequately represented. The 13 fish, ranging from 246 to 303 mm., gave an average of 266·5 mm., or $10\frac{1}{2}$ inches.

In the haul of 13th October all the fish were measured in the otter-trawl as well as the small net. The number belonging to the first series was on this occasion only 37, from 130 to 187 mm., with an average size of 160·3mm., or $6\frac{5}{16}$ inches. The second series was well marked, comprising 516 haddocks from 230mm. ($9\frac{1}{16}$ inches) to 327mm. ($12\frac{7}{8}$ inches), with a difference of 97mm. or $3\frac{13}{16}$ inches. The average size of this series was 281·9mm., or a little over $11\frac{1}{16}$ inches.

The annual increment of growth between the two series, as shown in this haul, is therefore 121·6mm., or a little over $4\frac{3}{4}$ inches. If the average of the second series of the 13th be compared with that of the much larger first series of the 8th, the increase in a year is very nearly the same, viz., 122·1mm. And since the interval between the hauls is only five days, the measurements may be combined with the following result, the imperfect second series in the first haul being omitted for the reasons stated.

	No.	Range. mm.	Difference. mm.	Av. Size. mm.	Year's Growth. mm.
1st Series,	515	118–199	81	159·8	—
2nd Series,	516	230–327	97	281·9	122·1

In the haul of the 13th, at least two other older generations are represented, but so scantily that the conclusion may be drawn that the great

bulk of them were elsewhere, perhaps off-shore. There are 27 haddocks from 330 to 391 mm., one at 423, and one at 495mm. The latter is at least two years older than the second series referred to above, but all the others, with the exception of the one at 423mm. belong to the third series. Including the odd one mentioned, the 28 haddocks, with a range of 93mm., have an average size of 356·7mm., or slightly over 14 inches. Examination of the curves (Plate XIII.) indicates that this average is too low for the group, and the number is small.

A haul by the "St. Andrew" in Aberdeen Bay, in 8 to 10 fathoms, on 31st October, yielded 157 haddocks, and another haul on the following day (1st November) produced 1610. Their measurements in centimetre groups are given in the following Table, the first line representing the first haul and the last the totals.

9	10	11	12	13	14	15	16	17	18
..	..	..	1		13	21	42	29	15
..	1	..	..	3	17	65	144	154	78
..	1	..	1	4	30	86	186	183	93
19	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**
3	2	..	..	..	..	2	3	7	4
18	..	3	1	3	11	24	92	157	200
21	2	3	1	3	11	26	95	164	204
29	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**
6	2	..	..	1	..	1	1	1	1
188	134	78	29	30	30	27	28	29	21
194	136	78	29	31	30	28	29	30	22
39	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**
..	..	1	2	..	..	..	..	..	..
15	9	6	3	4	2	2	..	2	..
15	9	7	5	4	2	2	..	2	..
49	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**
1	..	..	..	1	..	1	..	..	..
..	1	..	..	..	..	1	..	..	..
1	1	..	..	1	..	2	..	..	..
59	**60**	**61**	**62**	**63**	**64**	**65**	**66**	**67**	**68**
..	..	..	1	..	..	1	..	..	..
..	..	..	..	..	..	..	..	..	..
..	..	..	1	..	..	1	..	..	..

In the first haul of 31st October, 127 haddocks are comprised in the first series, ranging from 127 to 205 mm., with a difference between the smallest and the largest of 78mm., or $3\frac{1}{16}$ inches, and having an average size of 166·2mm., or $6\frac{9}{16}$ inches. There were no haddocks between 205mm. and 254mm., a gap of 49mm., and the second series begins at the size stated, viz., 254mm. It is scantily represented in this haul, and it is not very easy to say where its termination is, but it seems to be about 34cm. The number of haddocks comprised within it is 25, the largest being 332mm. (the next is 355mm.); the range is thus 78mm., and the average size 282·4mm., or $11\frac{1}{8}$ inches. The annual increase in size between the two series appears from the averages to be 116·2mm., or $4\frac{9}{16}$ inches, which is probably under the real amount.

There were twelve larger haddocks in this catch, varying from 355mm., or 14 inches, to 650mm., or a little over $25\frac{1}{2}$ inches. They obviously belong to two or three later series, but the numbers are too small to allow their limits to be assigned.

In the haul on 1st November two series are very well marked. The first, comprising 483 specimens from 135 to 222 mm., with a difference of 87mm., had an average size of 170·5mm., or $6\frac{11}{16}$ inches, 4·3mm. higher than the average of the previous haul. There is one haddock still smaller, viz., 104mm., and as the next largest is 135mm., or 31mm. (nearly $1\frac{1}{4}$ inches) more, it is excluded as probably belonging to an earlier series.

The next series begins at 232mm., but its termination is somewhat obscure. It will be seen from the Table given above, and the curve, that there is a rapid and regular decline from the maximum to 32cm., and that then a very slight rise occurs, and the line is prolonged at much the same level to 37cm., after which there is a gradual fall to 42cm. All these fishes can scarcely be included in one series as the curve shows, since it would give a range of 191mm., or over $7\frac{1}{2}$ inches. Most of them appear to be the smaller members of another series, the bulk of which was not on the grounds. The slope of the curve indicates a termination at about 35cm., and this slope corresponds with that of the more perfect curve of the October and December hauls (Pl. XIII.). On this basis the group comprises 976 haddocks from 232 to 349 mm., with a range of 117mm., or $4\frac{5}{8}$ inches, and the average size is 293·6mm., or $11\frac{9}{16}$ inches. The difference between the averages of the two series is 123·1mm., or $4\frac{7}{8}$ inches, and this represents the apparent annual increment of growth in this case.

Since, however, the hauls were taken on successive days and on the same grounds, the results of each may be combined, and then we have the following:—

	No.	Range. mm.	Difference. mm.	Av. Size. mm.	Year's Growth. mm.
1st Series,	610	127–222	95	169·6	—
2nd Series,	1001	232–349	117	293·3	123·7

The average for the first series is 169·6mm., or $6\frac{11}{16}$ inches, and for the second series 293·3mm., or $11\frac{9}{16}$ inches, and the amount of one year's growth from the smaller to the larger series, as shown by the difference of the averages, is 123·7mm., or $4\frac{7}{8}$ inches. The annual increment of growth deduced from these hauls corresponds closely with that obtained from earlier October averages, viz., 122·1mm., being only 1·6mm. higher. If it were assumed that growth was continuous and uniform throughout the whole year, the daily increment required to make up the

annual amount would be, on the mean of the four hauls, ·3367mm. Growth, however, is not uniform, but is arrested or retarded in winter, and comparison of the averages between the various hauls detailed above enables an estimate to be made of the actual increment of growth in the interval between them. The averages of the first series give the following:—

Date.	Interval.	No. of Fishes.	Average Size.	Apparent Growth in Interval.	Rate per Day.
	Days.		Mm.	Mm.	Mm.
8th Oct.	..	478	159·7	..	..
13th „	5 from 8th	37	160·3	0·6	·12
31st „	23 „ „	127	166·2	6·5	·2826
31st „	18 „ 13th	..	..	5·9	·3278
1st Nov.	24 „ 8th	483	170·5	10·8	·450
„ „	19 „ 13th	..	..	10·2	·5368

The rate deduced from these averages thus varies very considerably, even if the figures for the smaller catch of 37 fishes on 13th October be excluded. The mean of the five data is 0·3434mm. daily, or, excluding the catch referred to, 0.3993mm. Comparison of the two last groups, viz., 8th October with 478 fishes and 1st November with 438 fishes, gives probably the most trustworthy rate, 0·450mm., and this agrees fairly well with the mean for the two first hauls and the two last hauls, which is ·4455mm. Uniform growth at this rate would complete the full annual increment in about nine months.

The increase in the average of the second series is shown below, the 13 fishes in the imperfect record of 8th October being omitted (*see* p. 191).

Date.	Interval.	No. of Fishes.	Average Size.	Apparent Growth in Interval.	Rate per Day.
	Days.		Mm.	Mm.	Mm.
13th Oct.	..	516	281·9	15·4	..
31st „	18 from 13th	25	282·4	0·5	·0278
1st Nov.	19 „ „	976	293·6	11·7	·6158

The variation here is still more marked, owing no doubt to the very small number of fishes on the 31st October. The mean of the averages

is ·3218. Comparison of the 516 fishes of the 13th October with the 976 of the 1st November indicates a rate of 0·6158mm. per day. The mean daily rate of increase between the haul of 13th and the two last hauls is 0·60mm. It would require a much larger series of measurements to furnish the true equivalent, and all that can be said at present is that haddocks of these series grow about 4¾ inches in a year, and probably a little under ·5mm. daily in autumn.

In December a number of similar hauls were made by the "Star of Hope" in Aberdeen Bay. On the 17th, in 6–15 fathoms, 145 haddocks were taken; on the 19th two hauls were made, the first, in 6–8½ fathoms, yielding 94 haddocks, and the other, in 5–12 fathoms, yielding 496 haddocks (Pl. XIII.). The measurements are arranged in centimetre groups in the following Table, the first line containing those of the first haul, the second and third those on the 19th, while the fourth includes the haddocks (110) caught in three hauls on the 17th with the otter-net, but without the small-meshed net around it, and the last line gives the totals.

13	14	15	16	17	18	19	20	21	22	23
..	4	10	23	27	28	29	9	3	..	..
..	..	4	12	57	73	65	29	2	2	1
..	1	13	33	28	12	5	2	..	..	..
..	..	2	..	4	4	1	4	..	..	1
..	5	29	68	116	117	100	44	5	2	2

24	25	26	27	28	29	30	31	32	33	34
..	..	1	1	4	2	2	1	..	1	..
1	7	17	19	33	56	43	42	23	7	2
..	..	..	..	..	..	..	..	..	..	..
..	2	6	4	14	16	14	13	10	3	5
1	9	24	24	51	74	59	56	33	11	7

35	36	37	38	39	40	41	42	43	44	45
..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	1	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..
..	2	1	..	..	1	..	1	..	..	..
..	2	1	..	1	1	..	1	..	..	..

46	47	48	49	50	51	52	53	54	55	56
..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	1	..	..	..	..
..	..	..	..	..	..	1	..	..	..	

57	58	59	60	61	62	63	64	65	66	67
..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	1	..	..	..
..	..	..	..	..	..	..	1	..	..	..

In the haul of 17th December two series are represented. The first comprised 133 haddocks, from 143mm. to 211mm. in length, with a range of 68mm., and having an average size of 179·8mm., or $7\frac{1}{16}$ inches. The second series included only 12 fishes, from 260 to 336 mm.; they had an average size of 293·2mm., or $11\frac{9}{16}$ inches.

In the first haul on 19th December, 244 haddocks belonged to the first series, varying in size from 153 to 224 mm., the range being 71mm., or a little more than $2\frac{3}{4}$ inches, and the average size was 186·3mm., or $7\frac{5}{16}$ inches. The second series contained 251 fish, from 237 to 345 mm., with a range of 108mm., or $4\frac{1}{4}$ inches, and an average size of 295·3mm., or $11\frac{5}{8}$ inches.

In the second haul on 19th December the first series contained 94 haddocks, from 143 to 203 mm., with a range of 60mm. and an average size of 171·0mm., or nearly $6\frac{3}{4}$ inches. No other series was represented.

If the two hauls on the 19th are combined, we get for the first series of 338 fishes a range of 81mm. (from 143 to 224) and an average size of 182·0mm., or a little over $7\frac{1}{8}$ inches. If the three hauls on 17th and 19th are combined the range of the 471 haddocks of the first series is the same as the above, and the average size becomes 181·4mm. When the second series of 263 haddocks, represented only in two of the three hauls, is combined, the range is from 237 to 345 mm., with a difference of 108mm., and the average size is 295·3, the same, therefore, as in the preponderating haul of the 19th.

Comparison of the averages of the two series in the various hauls in which both are represented shows the difference between them to be less than in the October hauls. In the haul of 17th December it is 113·4mm.; in that of 19th December it is 109·0mm. The difference between the mean size of the first series in the two hauls of the 19th, and the mean for the second series on the 17th and 19th, is 113·3mm.; and that between the mean for the first series of the three hauls and the mean of the second series is 113·9mm. The amount of annual growth, then, as indicated by these December hauls, is about 113mm., or $4\frac{7}{16}$ inches, while in the October hauls it was about 123mm., or 10mm. more. The disparity is due to the low average for the second series, which was 295·3mm. for the December hauls, while it was 293·3mm. for the October-November hauls, 47 days earlier. This low December average may be partly caused by greater retardation of growth in the larger fishes than in the smaller, as the temperature falls, but it appears to be mainly caused by the relatively smaller number of haddocks belonging to the second series present in the December hauls, the larger individuals, as in the case of the whitings, leaving the inshore waters in greater numbers than the smaller ones late in the year. Thus, in the hauls on 8th–13th October the percentage of the second series represented was 50; in the hauls of 31st October–1st November the per-

centage was 62, and in the hauls in December it was only 36. For these reasons the annual increment of growth deduced from the October hauls is probably the more accurate.

Comparison of the averages at the different periods indicates the rate of growth in the intervals, and it also reveals the retardation associated with falling temperature. For the first series the particulars are as follows :—

Date.	Interval.	No. of Fishes.	Average Size.	Apparent Growth in Interval.	Rate per Day.
	Days.		Mm.	Mm.	Mm.
I. Oct. 8, 13	..	515	159·8	..	..
II. „ 31, Nov. 1	21	610	169·6	9·8	·4667
III. Dec. 17–19	69 from I.	471	181·4	21·6	·3130
„ „	48 „ II.	..	..	11·8	·2458

Although the precise rate might be considerably altered if the basis of calculation were wider, the regularity of the decline is of interest. In the first case it would take 242 days to complete an annual increment of 113mm., in the second case 361 days, and in the third case 455 days. To complete an annual increment of 123mm., the time required would be respectively 263, 389, and 500 days. The details in regard to the second series may also be given, but their interpretation is subject to the qualification above referred to with regard to the relative proportion of these fishes present in the hauls.

Date.	Interval.	No. of Fishes.	Average Size.	Apparent Growth in Interval.	Rate per Day.
	Days.		Mm.	Mm.	Mm.
I. Oct. 13	..	516	281·9	..	..
II. „ 31, Nov. 1	19	1001	293·3	11·4	·60
III. Dec. 17–19	66 from I.	263	295·3	13·4	·2030
„ „	47 „ II.	..	..	2·0	·0426

Several hauls were made with the small shrimp-trawl of the "Garland" in Aberdeen Bay in September, October, and November, and although the number of haddocks taken was very small the results may be given here. The hauls were as follows :—

I. 18–25th Sept., 5–15 fathoms.
II. 9th October, 16 „
III. 12th „ „
IV. 13th „ 13–16 „
V. 23rd Oct., 36½–49 fathoms.
VI. 24th „ 50½–60 „
VII. 7–9th Nov., 45–53 „

The measurements arranged in centimetre groups are subjoined:—

No. of Haul.	11	12	13	14	15	16	17	18	19	20	21
I.	..	1	6	4	3	1	..	..	..	..	..
II.	..	..	1	..	6	6	1	1	..	..	..
III.	..	..	1	2	2	..	1	..	..	..	..
IV.	..	..	1	..	2	3	..	1	..	..	..
V.	..	..	5	13	19	15	5	1	..	..	..
VI.	..	..	2	2	2	2	1	1	..	..	..
VII.	..	..	1	3	2	8	1	..	..	..	..

No. of Haul.	22	23	24	25	26	27	28	29	30	31	32
I.	..	..	1	..	1	5	..	..	..	..	1
II.	..	..	..	1	..	..	1	..	..	..	..
III.	..	..	2	1	1	1	..	..	..	..	..
IV.	..	..	..	..	1	2	..	..	..	..	..
V.	..	2	..	2	3	2	2	..	1	..	..
VI.	..	..	1	..	..	1	1	..	1	..	..
VII.	..	..	..	1	1	..	1	..	..	..	..

In a few hauls made between the 18th and 25th September in from 5–15 fathoms, 23 haddocks, in all, were captured. The first series contained 15 from 122 to 160 mm., with an average size of 142·1mm. The next series is represented by 7 specimens from 244 to 277 mm., with an average of 266·7mm. There was also a single specimen at 321mm., probably belonging to a later series.

The hauls on 9th, 12th, and 13th October combined yielded 38 haddocks, of which 28 belonged to the first series with a range of from 132 to 183 mm., a difference of 51mm., and an average size of 158·6mm. The second series contained 10, from 247 to 289 mm., the average size being 264·5mm.

In the two hauls on 23rd and 24th October 84 haddocks were taken. The first series comprised 68 fish from 131 to 186 mm., with a range of

55mm. and an average size of 157·6mm. The second series contained 16 haddocks, from 234 to 308 mm., with an average size of 268·8mm. The hauls on 7th and 9th November yielded 18 haddocks, of which 15, ranging from 138 to 175 mm., belonged to the first series, the average size being 151·5mm. The other three fish belonged to the second series, and were 253, 265, and 289 mm. long, the average being 269·0mm.

These averages correspond fairly well with those from hauls by trawlers at approximate dates, but they are under the latter, especially those of the second series, a circumstance no doubt due to the larger fishes more readily escaping capture by the small shrimp-trawl of the "Garland." The differences between the averages of the two series in the various hawls are respectively 124·6, 105·9, 111·2, and 117·5 mm.; in the one with the largest catch it is 111·2mm. The average of the 126 fish in the first series combined is 155·4mm., and in the 36 of the second series 267·2mm. The difference between them is 111·8mm., (4⅜ inches), which represents the amount of growth in one year, and is only 2·1mm. under the mean deduced from the December averages for the "Star of Hope." Here also the second series was not fully represented in the catches, the percentage being only 22 of the total.

2. The Moray Firth.

In a haul by the "Star of Hope," with the fine-meshed net around the cod-end, on the 10th October in 25 fathoms, off Dunbeath, Caithness, 308 haddocks were taken. Their measurements are arranged in centimetre groups as follows:—

11	12	13	14	15	16	17	18	19	20
1	1	3	..	..	..	..	..	..	..
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
1	..	..	10	29	55	68	49	28	10
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
6	4	8	11	8	6	3	5	..	2

The first series is represented by only 6 haddocks from 113 to 218mm., with an average of 144mm.

The second series comprises 259 specimens, ranging in size from 242 to 326 mm. From 242mm. the measurements form a symmetrical curve to 326mm., after which there is a rise and prolongation to about 39cm., in the same manner as is shown in the curve for this series in the haul in Aberdeen Bay on 1st November (*see* p. 193, Pl. XIII.), and probably capable of the same explanation. The range is 84mm., and the average size of the group is 276·3mm., or 10⅞ inches.

The remainder of the haddocks, 43 in number, appear to belong to another series only partially represented in the catch. Their size ranges

from 330 to 408 mm., the average size being 374·0mm., or about 14¾ inches.

The haddocks caught in a number of hauls by the "St. Andrew" in the Moray Firth were measured, the hauls being as follows:—

I. 3rd November, in 50 fathoms, about 30 miles west of Kinnaird Head, and about 12 miles from land.

II. 3rd November, in 12–14 fathoms, off Lossiemouth.

III. 5th November, in 7–11 fathoms, Dornoch Firth, small-meshed net.

IV. 5–7 November, in 8–12 fathoms, Dornoch Firth.

V. 8th November, in 35 fathoms, east of Smith Bank, small-meshed net.

The measurements, arranged in centimetre groups, are as follows:—

No.	12	13	14	15	16	17	18	19	20	21	22	23
I.	...	...	...	...	...	...	...	...	...	...	...	2
II.	...	...	1	...	...	...	...	...	...	...	...	...
III.	1	1	...	1	1	...	...	...	...	...	...	...
IV.	...	...	...	...	1	...	...	...	...	...	...	...
V.	...	...	5	6	3	4	1	1	1	...	1	...
Totals	1	1	6	7	5	4	1	1	1	...	1	2

No.	24	25	26	27	28	29	30	31	32	33	34	35
I.	10	27	52	40	23	20	12	21	24	31	33	19
II.	...	...	1	...	2	1	3	2	3	2	1	...
III.	...	...	...	...	...	1	...	...	1	...	...	1
IV.	...	5	...	4	3	2	5	2	22	20	15	15
V.	9	35	77	80	52	29	14	5	8	8	5	5
Totals	19	67	130	124	80	53	34	30	58	61	54	40

No.	36	37	38	39	40	41	42	43	44	45	46	47
I.	10	7	5	1	1	...	1	...	1	1	1	...
II.	2	...	...	...	1	...	...	...	...	...	...	...
.	...	2	...	1	...	1	...	...	...	1	...	...
IV.	13	10	6	3	3	8	3	2	1	4	...	4
V.	...	...	...	...	...	...	...	...	...	...	...	...
Totals	25	19	11	5	5	9	4	2	2	6	1	4

No.	48	49	50	51	52	53	54	55	56	57	58	59
I.	1	...	...	...	...	...	...	...	...	...	...	1
II.	...	...	...	...	...	...	...	1	...	1	...	...
III.	...	...	...	...	...	1	...	1	...	1	...	...
IV.	1	3	1	...	...	1	...	...	...	...	1	1
Totals	2	3	1	...	...	2	...	2	...	2	1	2

No.	60	61	62	63	64	65	66	67	68	69	70	71
I.	...	...	...	...	1	...	...	...	1	...	...	...
II.	...	...	...	1	1	...	...	...	1	...	...	...
III.	...	...	1	...	...	...	...	...	...	...	...	...
IV.	1	...	...	...	1	1	...	...	...	1	1	1
Totals	1	...	1	1	3	1	...	...	2	1	1	1

No.	72	73	74	75	76	77	78	79	80	81	82	83
II.	...	...	...	...	...	1	...	...	...	...	...	...

From this Table, and from the curves shown on Plate XII., it will be seen that these groups are fairly well represented in these hauls, and members belonging to later series are also present. Very few haddocks of the first series were caught, even when the small-meshed net was used. On the 5th (Haul III.) only 16 haddocks altogether were caught, a number too small to be of much service. In the haul on 8th (Haul V.), in 35 fathoms, 21 belonging to this series were taken, varying from 141mm. to 209mm., the range being 68mm., and the average size was 163·2mm., or $6\frac{7}{16}$ inches. The particulars for this series in all the hauls combined are 27 fishes, ranging from 127 to 209mm., with a range of 82mm., and an average size of 159·3mm.

The second series is the best-marked in most of the hauls, but there are interesting differences between some of them (*see* Pl. XII.). In that of 8th November, in 35 fathoms, east of Smith Bank, it will be observed that the curve of measurements is fairly symmetrical, and that it has the prolongation into the third series which was shown to exist in several previous cases. In the hauls in the Dornoch Firth, November 5–7 (No. IV.), the curve shows that very few of the second series were present, the haddocks belonging mostly to the third series. In the haul on 3rd November, in 50 fathoms (No. I.), the curve distinctly shows the presence of the third as well as the second series. These variations appear to be caused by the independent migratory movement of the fishes belonging to one and the same group.

In the haul on 3rd November, in 50 fathoms, the number of haddocks belonging to the second group was 187, from 236 to 309 mm., with a range of 73mm., and an average size of 270·8mm., or $10\frac{1}{3}$ inches. The third series of 152 fish, ranging from 311 to 405 mm., had an average size of 340·7mm., or $13\frac{7}{16}$ inches. In the haul of 8th November, in 35 fathoms, the second series contained 298 fishes, from 229 to 312 mm., with a range of 83mm., and an average size of 266·0mm., or $10\frac{7}{16}$ inches. The third series was represented by only 29 haddocks, and was obviously incomplete in range. The smallest was 315 and the largest 359 mm., the average size being 335·1mm., or $13\frac{3}{16}$ inches. In the combined hauls in Dornoch Firth, November 5th-7th, the second series is represented by only 19 fish, with an average of 280mm., and the third extending from 314 to 405 mm., and numbering 108 fishes, has an average size of 343·9mm., or $13\frac{9}{16}$ inches.

On Plate XII., fig. A, is represented curves of all the haddocks caught and measured in the Moray Firth in the hauls from 3rd to 9th November. The first series, containing 27 fishes, has been referred to. The second series comprised 505 haddocks, from 229 to 312 mm., the range being 83mm., and the average size 268·4mm., or $10\frac{9}{16}$ inches. The third series comprised 295 fishes, from 311 to 413 mm., the range being 102mm., and the average size 342mm., or $13\frac{7}{16}$ inches. The apparent annual increment of growth from the first to the second series was 109·1mm., or $4\frac{5}{16}$ inches, and from the second to the third 73·6mm., or $2\frac{7}{8}$ inches.

While the former may be regarded as approximately accurate, the latter is subject to some doubt, owing to the difficulty of fixing the end of the series, and the imperfect representation of the group as shown by the curves in the plate.

Besides these haddocks there were in the November hauls other 56 larger ones, whose size varied from 410mm., or $16\frac{1}{8}$ inches, to 770mm., or $30\frac{1}{4}$ inches. It is more difficult to separate these into groups, and further observations are desirable.

3. Deep Water.

In the hauls made in deep water by the "St. Andrew" in August, September, and October, a number of haddocks caught were measured. The measurements of the hauls on 31st August and 4th September, arranged in centimetre groups, are as follows:—

5	6	7	8	9	10	11	12	13	14
..	1	8	18	19	13	6	2	..	1
..	11	39	60	61	21	2	1	..	..
15	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
..	..	..	4	..	2	3	1	5	2
..	..	..	..	..	..	..	2	3	2
25	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**
1	..	..	..	..	..	..	..	..	..
2	4	4	5	8	17	37	40	44	45
35	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**
..	..	..	..	..	..	..	..	..	..
43	38	23	21	18	9	6	4	2	..

On 31st August, at about 65 miles S. E. by E. of Sumburgh Head, Shetland, in 62 fathoms, the small-meshed net was used around the cod-end, and 86 haddocks were taken in it. Those caught in the ordinary trawl-net were not measured on this occasion, so that the data are of use only in regard to the smaller forms. Of the 86 fish, 67, from 68 to 126 mm., formed a well-marked first series, with a range of 58mm. and an average size of 93·4mm., or $3\frac{1}{16}$ inches. The range was thus about $2\frac{1}{4}$ inches, from $2\frac{11}{16}$ inches to $4\frac{15}{16}$ inches. The other 19 haddocks varied from 148 to 252 mm. They appeared all to belong to a second series, only partly represented (Plate XIV.). The average size was 210·1mm., or $8\frac{1}{4}$ inches.

In a haul in the same locality, in $62\frac{1}{2}$ fathoms, on 4th September, 572 haddocks were taken. Those in the small-meshed net numbered 195, and all belonged to a first series, ranging in size from 61 to 120 mm. ($2\frac{3}{8}$–$4\frac{3}{4}$ inches), and with an average size of 87·1mm., or $3\frac{7}{16}$ inches. If this series is combined with that of 31st August, the average size of the 262 haddocks would be 88·7mm., and the range from 61 to 126 mm.

The remainder of the haddocks in this haul were measured in inches, and they belonged to two series. The first was imperfectly represented by 17 fish, from $8\frac{3}{4}$ to $10\frac{3}{4}$ inches, the average size being $9\frac{9}{10}$ inches, or about 251mm. The next series comprised 360 haddocks from $11\frac{1}{2}$ to $17\frac{1}{4}$ inches, the average being $13\frac{4}{5}$ ($13\frac{77}{100}$ inches, or about 350mm.

The haddocks taken in a haul with the ordinary net on 3rd September, in 65 fathoms, were measured to quarters of an inch; the measurements, transferred as nearly as possible to centimetre groups, are represented in fig. III., Pl. XIV. Two series were represented; one partially and imperfectly by 71 fish from $8\frac{1}{4}$ to $11\frac{1}{4}$ inches, with an average size of $9\frac{3}{5}$ inches, or about 243mm. The second series contained 1546 haddocks from $11\frac{1}{2}$ to $17\frac{1}{4}$ inches, the range being $5\frac{3}{4}$ inches, or about 147mm., and the average size barely 14 inches ($13\frac{96}{100}$), or about 354·8mm. This series for the two hauls combined, comprising 1906 haddocks, gives an average size of 354·0mm., or nearly 14 inches ($13\frac{93}{100}$ inches). The remaining 27 haddocks ranged from $17\frac{1}{2}$ to $22\frac{1}{4}$ inches.

Hauls were also made in deep water in October. On the 16th, in 65 fathoms, about 16 miles S.E. from Fair Isle, the small-meshed net being used, 673 haddocks were taken, and on the 19th, in the same locality, in 60 fathoms, 452 haddocks, the measurements of which are arranged in centimetre groups as follows, the first line containing those of the first haul, the second those of the haul on 19th, and the third the sum of both.

7	8	9	10	11	12	13	14	15	16
..	1	..	3	21	15	21	11	..	..
..	1	6	26	47	47	24	11	..	1
..	2	6	29	68	62	45	22	..	1
17	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**
..	..	..	2	7	3	19	24	41	31
..	..	..	..	1	1	7	15	21	37
..	..	..	2	8	4	26	39	62	68
27	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**
29	13	10	5	5	9	15	28	32	28
26	12	6	5	8	8	13	26	19	12
55	25	16	10	13	17	28	54	51	40
37	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**
29	28	45	31	23	29	16	19	11	13
15	13	7	7	9	3	3	2	2	2
44	41	52	38	32	32	19	21	13	15

47	48	49	50	51	52	53	54	55	56
12	8	6	10	5	3	2	2	2	2
..	..	..	1	2	2	..	1	1	..
12	8	6	11	7	5	2	3	3	2
57	**58**	**59**	**60**	**61**	**62**	**63**	**64**	**65**	**66**
..	1	3	..	..	..	..	..	..	..
..	..	..	1	..	..	..	..	1	..
..	1	3	1	..	..	..	..	1	..

The curves formed by these measurements are shown on Plate XV.

In the haul of 16th October, the first series contained 72 haddocks from 84 to 145 mm., with an average size of 125·9mm., or $4\frac{5}{16}$ inches. The smallest specimen, measuring 84mm., is separated from the next (103mm.) by an interval of 19mm. In the haul of 19th October the corresponding series comprised 162 haddocks from 82 to 148 mm., with a range of 66mm. and an average size of 116·1mm., or $4\frac{9}{16}$ inches. In this case also the smallest fish is separated from the others by a considerable interval (10mm.); a 2mm. grouping shows the following order, from 80mm. on:—0, 1, 0, 0, 0, 0, 2, 2, 1, 1, 0, 3, 6, &c. There was a haddock at an anomalous size, viz., 167mm. (the next being 218mm.), which probably represents an older group that is missing from these hauls.

It will be seen that there is a difference of nearly 10mm. between the average of this series in the two hauls; the average of the combined series (234 fishes) is 119·1mm., or $4\frac{11}{16}$ inches. The average size of the corresponding series on August 31st was 93·4mm., and on 4th September 87·1, the average for the combined series, of 262 fishes, being 88·7mm. The hauls were made in deep water on each occasion, but at some distance apart. It is probable that any variation in size due to this circumstance would be inconsiderable at this stage, and if the series in the two cases are really comparable, the mean averages indicate that in the interval of 45 days the amount of growth that occurred was 30·4mm. ($1\frac{3}{16}$ inches), or at the rate of ·6755mm. daily. If this rate of growth were continued for the six months May-October, it would aggregate 103·4mm., or $4\frac{1}{16}$ inches, and since the average size of the October fish of this series is only $4\frac{1}{16}$ inches, it is clear that the fish of this series were spawned in the spring of 1900. The averages, it has been said, vary in the different hauls, and if each of them is compared, the respective differences shown are 22·7mm., 29·0mm., 32.5mm., and 38·8mm.

Other two series are well represented in these October hauls. The first of these is especially well marked, as also in another haul on 18th October, made without the small-meshed net around the cod-end of the trawl. The measurements of the 1451 haddocks in the latter case, grouped in centimetres, are shown in the following Table:—

12	13	14	15	16	17	18	19	20	21
..	1	..	..	..	..	..	..	..	..
22	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**
5	42	82	120	142	95	46	25	23	30
32	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**
65	80	102	87	87	79	63	42	46	39
42	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**51**
22	21	9	17	18	7	5	4	3	4
52	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**	**61**
6	2	3	5	3	2	4	2	1	1
62	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**	**71**
..	..	5	1	..	..	..	1	..	..

Curves of these measurements are given on Plate XV. In the haul of 16th October the first of the two series referred to comprised 184 fishes, from 202 to 309 mm., with a range of 107mm. and an average size of 257·5mm., or $10\frac{1}{8}$ inches. The same series in the haul of 19th October contained 131 haddocks, from 218 to 309 mm., with a range of 91mm. and an average size of 265·3mm., or $10\frac{7}{16}$ inches. In the haul of 18th October the series comprised 580 haddocks, from 222 to 308 mm., with a range of 87mm., and an average size of 263·5mm., or $10\frac{3}{8}$ inches. The mean for the 895 haddocks of the three hauls is 262·5mm., or $10\frac{5}{16}$ inches, and the range of size is from 202mm. ($7\frac{15}{16}$ inches) to 309mm. ($12\frac{3}{16}$ inches), the difference thus being 107mm., or $4\frac{3}{16}$ inches.

Comparison of these averages with those of the corresponding series in August and September is perhaps not quite reliable, partly because the series was then imperfectly represented in the hauls, and partly because the measurements were made on the inch scale. But so far as the series can be shown, the mean average on 3rd and 4th September was, for 88 fishes, 244·7mm. This would indicate an approximate growth for the fish in this series of 17·8mm., or $\frac{11}{16}$ of an inch, in 44 or 45 days during September and October.

The next series represented in the hauls is not so easily analysed. It will be seen from the figures on the Plate that the curves are irregular and the range extended, and that the termination of the series is not easy to determine. In the haul of 16th October it began at 310mm. and appears to end about 439mm., with a range of 129mm., or $5\frac{1}{8}$ inches, and the 318 fishes comprised in it have an average size of 381·9mm., or nearly 15 inches. In the haul of 19th October it begins at 310mm. and appears to end about 444mm., with a range of 134mm., or $5\frac{1}{4}$ inches, and it comprises 145 fishes with an average size of 361·3mm., or $14\frac{3}{16}$ inches. A glance at the curves on the Plate will, however, show that in the haul of the 16th the larger members of this series were unduly represented, while the opposite occurred in the haul of the 19th. When the measurements are combined, the average size deduced is 375·5mm., or $14\frac{3}{4}$ inches.

In the haul on 18th October this series is much better shown. It begins at 309mm. and ends apparently at 445mm., with a range of 136mm. and an average size for the 772 fish contained in it of 369·5mm., or slightly over $14\frac{1}{2}$ inches. The combinations of the measurements for the three hauls gives for the 1235 haddocks an average size of 371·5mm., or $14\frac{5}{8}$ inches, and a range of 136mm. ($5\frac{5}{16}$ inches), the smallest being 309mm. ($12\frac{3}{16}$ inches), and the largest 445mm. ($17\frac{1}{2}$ inches).

Comparison with the measurements of the corresponding series in September, when the mean of the combined haul was 354·0mm., indicates a growth in the 44 or 45 days of 17·5mm., almost exactly the same as the amount of growth deduced above for the preceding series (viz., 17·8mm.).

The mean averages for the various hauls in deep water are given in the following Table:—

Series.	Date.	No. of Fish.	Size—Mm.			Apparent Growth in Interval of 46 Days.
			Range.	Difference.	Average Size.	
						Mm.
1st . .	31 Aug.–4 Sept.	262	61-126	65	88·7	...
,, . .	16, 19 Oct.	234	82-148	66	119·1	30·4
2nd . .	3, 4 Sept.	88	210-286	75	244·7	...
,, . .	16, 18, 19 Oct.	895	202-309	107	262·5	17·8
3rd . .	3, 4 Sept.	1906	292-438	146	354	...
,, . .	16, 18, 19 Oct.	1235	309-445	136	371·5	17·5

It will be seen that the differences in the average size of the various series are, for those of August and September, 156·0mm. between the first and the second, and 109·3mm. between the second and the third. In those of October the respective differences are 143·4mm. and 109·0mm. The very close correspondence between the second and third series in the two cases is remarkable, and makes it fairly certain that the mean annual increment of growth between these series amounts to about 109mm., or $4\frac{1}{4}$ inches. The difference between the first and second series can hardly be so interpreted. In one instance it would show an annual growth of $6\frac{1}{8}$ inches, and in the other instance a growth of $5\frac{5}{8}$ inches, both of which are considerably higher than the

corresponding annual increments for the fish caught in Aberdeen Bay and the Moray Firth.

I append a Table giving particulars of the 9346 haddocks measured in the various hauls.

Date.	Depth.	No. of Fish.	Size.				Apparent Annual Growth from preceding Series.	
			Range.	Difference.	Average.			
Aberdeen Bay.	Fms.		Mm.	Mm.	Mm.	Inches.	Mm.	Inches.
8 *Oct.*	12–14							
A Series . .		478	118-199	81	159·7	6 5/16	...	...
B ,, . .		13	246-303	57	266·5	10 1/2	106·8	4 3/16
13 *Oct.*	8–18							
A Series . .		37	130-187	57	160·3	6 5/16	...	...
B ,, . .		516	230-327	97	281·9	11 1/16	121·6	4 13/16
C ,, . .		28	330-423	93	356·7	14	74·8	2 15/16
Average.								
A Series . .		515	118-199	81	159·8	6 5/16	...	...
B ,, . .		516	230-327	97	281·9	11 1/16	122·1	4 13/16
31 *Oct.*	8–10							
A Series . .		127	127-205	78	166·2	6 9/16	...	...
B ,, . .		25	254-332	78	282·4	11 1/8	116·2	4 9/16
1 *Nov.*	12–15							
		[1	104	...	104	4 1/16]	...	...
A Series . .		483	135-222	87	170·5	6 11/16	...	...
B ,, . .		976	232-349	117	293·6	11 9/16	123·1	4 7/8
Average.								
A Series . .		610	127-222	95	169·6	6 11/16	...	...
B ,, . .		1001	232-349	117	293·3	11 9/16	123·7	4 7/8
17 *Dec.*	6–15							
A Series . .		133	143-211	68	179·8	7 1/16	...	...
B ,, . .		12	260-336	76	293·2	11 9/16	113·4	4 7/16
19 *Dec.*	5–12							
A Series . .		244	153-224	71	186·3	7 3/8	...	...
B ,, . .		251	237-345	108	295·3	11 5/8	109·0	4 1/4
19 *Dec.*	6–8½							
A Series . .		94	143-203	60	171·0	6 3/4	...	...
Average.								
A Series . .		471	143-224	81	181·4	7 1/8	...	...
B ,, . .		263	237-345	108	295·3	11 5/8	113·9	4 1/2

Date.	Depth.	No. of Fish.	Size.				Apparent Annual Growth from preceding Series.	
			Range.	Difference.	Average.			
Aberdeen Bay— *continued.*	Fms.		Mm.	Mm.	Mm.	Inches.	Mm.	Inches.
18-25 *Sept.*	5–15							
A Series . .		15	122-160	38	142·1	$5\frac{9}{16}$	...	...
B ,, . .		7	244-277	33	266·7	$10\frac{1}{2}$	124·6	$4\frac{14}{16}$
9-13 *Oct.*	13–16							
A Series . .		28	132-183	51	158·6	$6\frac{1}{4}$	...	...
B ,, . .		10	247-289	42	264·5	$10\frac{7}{8}$	105·9	$4\frac{3}{16}$
23, 24 *Oct.*								
A Series . .		68	131-186	55	157·6	$6\frac{3}{16}$	..	...
B ,, . .		16	234-308	74	268·8	$10\frac{9}{16}$	111·2	$4\frac{3}{8}$
7, 9 *Nov.*								
A Series . .		15	138-175	37	151·5	$5\frac{11}{16}$	. .	...
B ,, . .		3	253-289	36	269·0	$10\frac{9}{16}$	117·5	$4\frac{5}{8}$
Moray Firth.								
10 *Oct.*	25							
A Series . .		6	113-218	103	144	$5\frac{11}{16}$	...	...
B ,, . .		248	242-308	66	274·3	$10\frac{13}{16}$	130·3	$5\frac{1}{8}$
C ,, . .		51	312-408	78	363·7	$14\frac{5}{16}$	89·4	$3\frac{1}{2}$
3 *Nov.**	50							
B Series . .		187	236-309	73	270·9	$10\frac{11}{16}$	...	...
C ,, . .		152	311-405	94	340·7	$13\frac{7}{16}$	69·8	$2\frac{3}{4}$
5 *Nov.*	7–11							
A Series . .		4	127-160	33	143·2	$5\frac{5}{8}$	...	...
B ,, . .		1	295	...	...	...	...	...
C ,, . .		6	328-413	85	373·5	$14\frac{11}{16}$	...	...
8 *Nov.*†	35							
A Series . .		21	141-209	68	163·2	$6\frac{7}{16}$	...	...
B ,, . .		298	229-312	83	266·0	$10\frac{7}{16}$	102·8	$4\frac{1}{16}$
C ,, . .		29	315-359	44	335·1	$13\frac{3}{16}$	69·1	$2\frac{3}{4}$
5-7 *Nov.*‡	8–12							
B Series . .		19	250-305	55	280·0	11	...	...
C ,, . .		108	314-405	91	343·9	$13\frac{9}{16}$	63·9	$2\frac{1}{2}$
D ,, . .		...	...	...	...	...	...	...
Nov. **Average.**								
A Series . .		27	127-209	82	159·3	$6\frac{1}{4}$	...	...
B ,, . .		505	229-312	83	268·4	$10\frac{9}{16}$	109·1	$4\frac{5}{16}$
C ,, . .		295	311-413	102	342·0	$13\frac{7}{16}$	73·6	$2\frac{7}{8}$
D ,, . .		...	...	...	...	...	...	...

* Otter-trawl. † Ordinary Otter-trawl. ‡ Other hauls.

Date.	Depth.	No. of Fish.	Size.				Apparent Annual Growth from preceding Series.	
			Range.	Difference.	Average.			
Deep Water.	Fms.		Mm.	Mm.	Mm.	Inches.	Mm.	Inches.
31 *Aug.**	62							
A Series . .		67	68-126	58	93·4	$3\frac{11}{16}$	...	...
B ,, . .		19	148-252	102	210·1	$8\frac{1}{4}$	...	...
4 *Sept.*	$62\frac{1}{2}$							
A Series . .		195	61-120	59	87·1	$3\frac{7}{16}$	...	...
†B ,, . .		17	222-273	51	251	$9\frac{7}{8}$	...	...
†C ,, . .		360	292-438	146	360	$13\frac{177}{100}$	99	$3\frac{7}{8}$
3 *Sept.*	65							
†B Serie . .		71	210-286	76	243	$9\frac{9}{16}$	...	...
†C ,, . .		1546	292-438	146	354·8	$13\frac{96}{100}$	117·8	$4\frac{5}{8}$
Aug.-Sept. **Averages.**								
A Series . .		262	61-126	65	88·7	$3\frac{1}{2}$	...	...
‡B ,, . .		88	210-286	76	244·7	$9\frac{5}{8}$	[156	$6\frac{1}{8}$]
C ,, . .		1906	292-438	146	354·0	$13\frac{93}{100}$	109·3	$4\frac{5}{16}$
16 *Oct.*	65							
A Series . .		72	84-145	61	125·9	$4\frac{11}{16}$	...	...
C . .		184	202-309	107	257·5	$10\frac{1}{8}$	131·6	$5\frac{3}{16}$
D ,, . .		318	310-439	129	381·9	15	124·4	$4\frac{7}{8}$
19 *Oct.*	60							
A Series . .		162	82-148	66	116·1	$4\frac{9}{16}$	...	...
B ,, . .		1	167	...	...	...	...	...
C ,, . .		131	218-309	91	265·3	$10\frac{7}{16}$	149·2	$5\frac{7}{8}$
D ,, . .		145	310-444	134	361·3	$14\frac{3}{16}$	96	$3\frac{3}{4}$
18 *Oct.*§								
C Series . .		580	222-308	86	263·5	$10\frac{3}{8}$	...	...
D ,, . .		772	309-445	136	369·5	$14\frac{1}{2}$	106·6	$4\frac{1}{4}$
Oct. **Averages.**								
A Series . .		234	82-148	66	119·1	$4\frac{11}{16}$	...	...
C ,, . .		895	202-309	107	262·5	$10\frac{5}{16}$	143·4	$5\frac{5}{8}$
D ,, . .		1235	309-445	136	371·5	$14\frac{5}{8}$	109·0	$4\frac{5}{16}$

* Fish in small-meshed net only. † Measured to fractions of an inch.
‡ 31st August omitted. § Otter-trawl only.

SUMMARY.

The haddock spawns somewhat earlier than the cod and considerably earlier than the whiting. In the inquiry made some years ago as to its spawning season, it was found that the greater number spawned from towards the end of February to the end of March. Some were found ripe early in January, and a few as late as the beginning of May.* Eggs, identified as those of the haddock, have been described as taken in tow-nets from 8th February to early in June;† but considering the difficulty of differentiating them from cod eggs in the preserved condition, and the small number (four) found in June, the latter part of the statement must be received with reserve. According to Cunningham, the haddock spawns in the North Sea in February, March, and April, especially in March.‡ Holt also found that it spawned on the west coast of Ireland chiefly in March and April.§

The temperature of the sea at the surface on the East Coast is about 41° F. in February, 40° in March, 43·5° in April, and 46·5° in May, and according to the experiments of Mr. Dannevig on the rate of development of haddock eggs under different temperatures,‖ the duration of hatching in these various months would be about 19 or 20 days in February, 17½ in March, 15½ in April, and 13 in May. It is probable, therefore, that the majority of the larval haddocks emerge from the egg in the early part of April.

Information as to the post-larval and young haddock is still somewhat scanty. In Christiania Fjord, Collett found them ranging from 40mm. to 50mm. long in June (14th), and they were found at Spitzbergen in September about 35mm. in length.¶ M'Intosh states that they were taken in great numbers in the midwater net, 25 to 30 miles east-by-south of May Island, and near the "Long Forties," in the first weeks of July, ranging in length from 24 to 80 mm.** They were also found in July in the deep water of the Moray Firth, ranging about one inch in length.†† Holt has recorded a post-larval haddock from the Faeröe-Shetland Channel at the end of July or beginning of August.‡‡

The smallest haddocks obtained by me during this investigation were those caught in the deep-water hauls on 31st August and 4th September, and they ranged from 61mm. ($2\frac{3}{8}$ inches) to 126mm. ($4\frac{15}{16}$ inches), the average length being 88·7mm., or $3\frac{1}{2}$ inches. They were clearly the brood of the year, and the majority were probably hatched in April. In October, at another place, about 50 miles westward, they ranged from 82 to 148 mm.—that is, up to $5\frac{13}{16}$ inches—the average being $4\frac{11}{16}$ inches, and they were probably about six months old. The difference between the averages was 30·3mm., or $1\frac{3}{16}$ inches, and presuming the last two lots were comparable, this would represent the mean increase in length in the 44 or 46 days that intervened. It is, however, to be noticed that in both months the hauls which contained the larger number of young haddocks had the lowest average (viz., 4th September, 19th October), and it is probable that numbers of the smaller individuals escaped through

* *Tenth Ann. Rep. Fish. Board for Scot.*, Part iii., p. 233.
† Masterman, *op. cit.*, *Fifteenth Rep.*, Part iii., p. 225.
‡ *Jour. Mar. Biol. Assoc.*, ii., 359.
§ *R. Dub. Soc. Rep. Council*, p. 249 (1892).
‖ *Thirteenth Ann. Rep.*, Part iii., 149.
¶ *Scandinavian Fishes*, i., p. .
** *Fifteenth Ann. Rep. F. B. for Scot.*, Part iii., p. 198.
†† *Eighth Ann. Rep.*, *ibid.*, 174.
‡‡ *Proc. Zool. Soc.*, 1900.

the meshes of the net. This would cause the average for each lot to be unduly high; but it would not materially affect the difference between the means for the two periods. Thus, in the hauls which had the fewest young haddocks (31st August, 16th October), the difference between the averages is 32·5mm.

When, however, the result of the investigation in the inshore waters of Aberdeen Bay and the Moray Firth are considered, we find a contrast to those referred to in the deep water. In Aberdeen Bay, for example, on 18–25th September the young haddocks caught averaged 142·1mm., or over 5½ inches in length, some being 6¼ inches. In October the average size in various hauls was 159·7, 160·3, 166·2, 158·6, 157·6 mm., or from 6¼ to 6½ inches; and some of those belonging to the same series were as large as 7$\frac{3}{16}$ inches, while the smallest was 4$\frac{5}{8}$ inches. The difference between the average size of those taken in the deep water and those taken in Aberdeen Bay about the same time was thus over 40mm., or more than 1½ inches.

The differences in size between the annual groups or generations may now be considered. The differences between the average size of the first and second series in the cases where both are represented, or, in other words, the apparent annual increment of growth, are as follows:—

	No. of Fish.		Apparent Annual Growth.	
	1st Series.	2nd Series.		
			Mm.	Inches.
13 October . . .	37	516	121·6	4$\frac{3}{4}$
8 and 13 October .	515	516	122·1	4$\frac{13}{16}$
31 October . . .	127	25	116·2	4$\frac{9}{16}$
1 November . .	483	976	123·1	4$\frac{7}{8}$
17 December . .	133	12	113·4	4$\frac{7}{16}$
19 ,, . .	244	251	109·0	4$\frac{5}{16}$
17–19 ,, . .	471	263	113·3	4$\frac{7}{16}$
18–25 September . .	15	7	124·6	4$\frac{15}{16}$
9–13 October . .	28	10	105·9	4$\frac{3}{16}$
23–24 ,, . .	68	16	111·2	4$\frac{3}{8}$
7–9 November . .	15	3	117·5	4$\frac{5}{8}$
10 October . . .	6	259	132·3	5$\frac{3}{16}$
8 November . .	21	298	102·9	4$\frac{1}{16}$

It will be observed from these figures that while there is a difference between the apparent yearly growth, amounting in the two extreme cases to slightly over an inch, the agreement is on the whole very considerable. In the exceptional case where the growth appears to be 5$\frac{3}{16}$ inches, the number of fishes in the first series was only 6. If this example be excluded, the difference is very considerably reduced. The growth of the

haddock, therefore, between the first and second series in the course of a year may be placed at about $4\frac{3}{4}$ inches.

The second series—as represented in Aberdeen Bay in hauls from 8th October to 1st November, comprising 1001 haddocks—ranged in size from 232mm., or $9\frac{1}{8}$ inches, to 349mm., or $13\frac{3}{4}$ inches, the average size being 293·3mm., or $11\frac{9}{16}$ inches. In December this group (comprising 263 fishes) had almost the same range and average size ($11\frac{5}{8}$ inches). In the Moray Firth in October and November the average size was less, viz., 266 to 276·3 mm., or $10\frac{1}{2}$ to $10\frac{7}{8}$ inches, the number of fishes comprised being 722.

The next series was scarcely represented in the hauls in Aberdeen Bay. In the Moray Firth on 3rd November they ranged from 302 to 399 mm., with an average size of 337·7mm., or $13\frac{5}{16}$ inches. Haddocks of this series were most abundant on the deep-water grounds both at the beginning of September and the middle of October. On 3rd and 4th September 1906 were measured, and they ranged from $11\frac{1}{2}$ to $17\frac{1}{4}$ inches, with a calculated average size of 354mm., or 14 inches. On 16–19th October 1235 were measured. They ranged from 309mm., or a little over 12 inches, to 445mm. or $17\frac{1}{2}$ inches, the average size being 371·5mm., or $14\frac{5}{8}$ inches.

When the mean sizes of this and the previous series are contrasted, the difference, or the apparent annual increment of growth, varies in different hauls as follows, the first referring to the Moray Firth and the others to the deep-water grounds.

	No. of Fish.		Apparent Annual Growth.	
	2nd Series.	3rd Series.		
			Mm.	Inches.
3 November . .	175	163	69·2	$2\frac{3}{4}$
3 September . .	71	1546	111·8	$4\frac{3}{8}$
4 ,, . .	17	360	109·0	$4\frac{5}{16}$
16 October . . .	184	318	124·4	$4\frac{7}{8}$
18 ,, . . .	580	772	106·0	$4\frac{3}{16}$
19 ,, . . .	131	145	96·0	$3\frac{13}{16}$

The annual increment of growth is thus slightly lower than between the first and second series, and in the best examples (16th and 18th October) is slightly under $4\frac{1}{2}$ inches.

The female haddock may reach maturity when about twelve or thirteen inches in length, and the male when somewhat smaller, but the majority probably do not spawn until they are somewhat larger. The second series, with the sizes in October above referred to, would therefore take little part in the spawning in the following spring, although many of them would no doubt do so. The great spawning shoals are composed of the third series. The first series, represented in Aberdeen Bay in October with an average size of about $6\frac{5}{16}$ inches and ranging from $4\frac{5}{8}$ to $8\frac{3}{4}$ inches, are the fish of the year, and are then about 7 or 8 months old. The next series is about 1 year and 7

months old, with an average size of 11½ inches and a range up to 13¾ inches; and the third series is about 2 years and 7 months old, with an average size of 13½ or 14 inches and a range up to 17½ inches.

It thus appears that some haddocks may spawn when about 2 years of age, and that the great majority do not do so until they are 3 years old.

THE COD (*Gadus callarias, L.*).

I. Hauls in Aberdeen Bay.

A considerable number of cod got in the hauls made in Aberdeen Bay by the trawlers "Star of Hope" and "St. Andrew" and by the "Garland" in September, October, November, and December were measured.

On 8th October a haul (I.) of the "Star of Hope, with the small-meshed net around the cod-end, in 12 to 14 fathoms, yielded 49 cod; another (II.) by the St. Andrew," on 31st October, in 8–10 fathoms, yielded 201 cod; a haul (III.) on the next day, in 12–15 fathoms, yielded 82, and a haul (IV.) on 9th November, in 9 fathoms, yielded 41. In this case 35 of the fish were above 27 inches in length, and are at present not dealt with, but the measurements of the others in centimetre groupings are as follows. The hauls are numbered consecutively.

Haul.	8	9	10	11	12	13	14	15	16	17	18
I.	4	10	7	6	3	1	4	3	4	..	..
II.	2	19	43	46	38	16	12	5	8	4	2
III.	6	7	12	18	15	2	4	4	4	1	..
IV.	1	1	3	..	..	1	..	..	..	..	..

Haul.	19	20	21	22	23	24	25	26	27	28	29
I.	1	..	..	1	..	2	1	..	1	..	1
II.	..	..	..	..	..	..	..	1	..	1	..
III.	..	..	1	1	..	1	..	1	2	..	3
IV.	..	..	..	..	..	..	..	..	..	..	..

Haul.	30	31	32	33	34	35	36	37	38	39	40
I.	..	..	..	..	..	..	..	..	..	..	..
II.	..	1	1	..	..	..	..	..	..	..	..
III.	..	..	1	..	..	..	..	..	..	..	..
IV.	..	..	..	..	..	..	..	..	..	..	..

Haul.	41	42	43	44	45	46	47	48	49	50	51
I.	..	..	..	..	..	..	..	..	..	..	..
II.	..	..	..	..	..	..	1	..	1	..	..
III.	..	..	..	..	..	..	..	..	..	..	..
IV.	..	..	..	..	..	..	..	..	..	..	..

The Table shows the existence of three series, and, as stated above, in the haul on 9th November 35 cod were taken measuring from 27 to 40½ inches (about 68·5 to 102·9 cm.) and belonging to older groups.

In the haul of 8th October the first series contained 42 cod from 80 to 166 mm., with a range of 86mm. and an average size of 116·5mm., or $4\frac{9}{16}$ inches. The other 7 fish ranged from 199 to 291 mm., with an average size of 247·3mm., or $9\frac{3}{4}$ inches.

In the haul of 31st October the first series comprised 195 cod from 88 to 183 mm., with a range of 95mm. and an average size of 120·4mm., or $4\frac{3}{4}$ inches. Other four range from 263 to 329 mm., and two measured 472 and 493 mm., and belong to a third series. The first series in the haul of 1st November contained 73 cod from 83 to 172 mm., the range being 89mm, and the average size 118·5mm., or nearly $4\frac{11}{16}$ inches. The other 9 ranged from 216 to 325 mm., the average size being 275·8mm.

These two hauls, made on successive days, may be combined, and then the 268 fish of the first series have an average size of 119·9mm., or a little over $4\frac{11}{16}$ inches, the range being from 83mm. ($3\frac{1}{4}$ inches) to 183mm. ($7\frac{3}{16}$ inches), with a difference of 100mm., or $3\frac{15}{16}$ inches.

The small cod caught in the haul of 9th November were six, ranging from 87 to 131 mm., with an average size of 105·5mm., or $4\frac{1}{8}$ inches.

A number of similar hauls were made by the "Star of Hope" in December, viz.—I. on 17th, in 8–15 fathoms; II. on 18th, in 8 fathoms; III. on 19th, in 5–12 fathoms; IV., also on 19th, in 6–8 fathoms; and V. on 21st, in 7 fathoms and less. The measurements of the cod secured in these hauls are arranged in centimetre groups in the following Table:—

Hauls.	6	7	8	9	10	11	12
I.	..	..	..	..	3	4	10
II.	..	..	7	22	12	2	..
III.	..	5	35	39	31	16	9
IV.	..	1	4	10	4	1	..
V.	..	..	3	32	30	23	10
Totals,	..	6	49	103	80	46	29

Hauls.	13	14	15	16	17	18	19
I.	11	7	1	2	..	..	..
II.	..	..	..	..	..	..	..
III.	8	7	3	..	1	1	..
IV.	..	..	..	..	..	..	..
V.	9	1	3	1	1	1	..
Totals,	28	15	7	3	2	1	..

The 38 cod caught on the 17th belonged to the first series, and measured from 106 to 162 mm., with a range of 56mm. and an average size of 131·1mm., or nearly $5\frac{3}{16}$ inches. No second series was represented.

In the haul on 18th the first series comprised 43 cod from 82 to 119 mm., with a range of 37mm., and an average size of only 97·2mm., or $3\frac{13}{16}$ inches.

In the first haul on 19th 155 cod were taken, all belonging to the same series, and measuring from 75 to 183 mm., with a range of 110mm. and an average size of 103·8mm., or $4\frac{1}{8}$ inches. In the second haul on the same day the 20 cod taken ranged from 79 to 111 mm., and had an average size of only 93·8mm., or about $3\frac{11}{16}$ inches.

In the haul on 21st 114 cod were caught, ranging in size from 84 to 188 mm., with a difference of 104mm. and an average size of 111·7mm., or $4\frac{3}{8}$ inches.

The averages, it will be seen, vary considerably, and since only four days elapsed between the hauls they may be combined as follows:—

No. of Fish,	Range,	Difference,	Average Size,
370	75–188 mm.	113mm.	107·7mm.

The young cod of this series in Aberdeen Bay, in December, would therefore appear to vary in size from about $2\frac{15}{16}$ inches to $7\frac{3}{8}$ inches, with an average size of $4\frac{3}{4}$ inches.

But we have already seen that in October in Aberdéen Bay the average size was still greater (p. 215). Only in one of the December hauls (17th) was the average higher. This is probably accounted for by the departure of the larger individuals of the series as the temperature falls in the inshore waters, which would likewise explain the absence of the next or second series at this time. It is also partly due to the circumstance that the October hauls extended into deeper water, the deepest hauls as a rule giving the largest average size.

In order to determine such problems a number of hauls were made by the "Garland" with a fine-meshed shrimp-trawl ($\frac{1}{4}$-inch mesh) along lines parallel with the shore at various depths and distances. The inefficiency of this vessel, however, rendered the observations of comparatively little value, very few codling being caught.

In the Table below, the measurements of the cod are arranged in centimetre groups.

Haul.	5	6	7	8	9	10	11	12	13	14
I.	..	..	..	1	..	..	..	1	..	..
II.	..	1	1	3	1	1	..	..	..	..
III.	..	..	..	3	2	4	..	..	..	1
IV.	..	..	2	10	7	5	1	1	..	..
V.	..	..	1	8	..	4	1	..	..	..

Haul.	15	16	17	18	19	20	21	22	23	24
I.	..	..	..	..	..	..	1	..	..	..
II.	..	..	..	..	..	1	1	1	2	..
III.	1	..	..	..	..	..	..	..	..	2
IV.	..	..	..	..	..	..	1	..	1	..
V.	..	..	..	..	..	..	..	..	..	..

Haul.	25	26	27	28	29	30	31	32	33	34
I.	..	..	1	..	..	..	..	..	..	..
II.	..	3	4	..	2	..	..	..	..	..
III.	1	1	..	..	2	..	1	1	1	..
IV.	..	..	..	3	..	..	..	..	..	..
V.	..	2	2	2	1	..	..	1	..	..

In a haul (I.) in 5–5½ fathoms, on 21st September, 4 codlings were taken which measured 82, 124, 217, and 273 mm. respectively. Three hauls on 22nd September in 10–15 fathoms, and three on 25th in 23–27 fathoms, yielded 21 young cod (II.), and of the six got in the deeper water five measured from 68 to 86 mm. Of the lot 9 measured from 68 to 124 mm., with an average of 88·6mm.; 16 measured from 209 to 296 mm., with an average of 255·5mm. On 9th October, of 20 taken in from 12 to 16 fathoms (III.), 11 belonged to a first series, ranging from 83 to 157 mm., and with an average size of 105·0mm.; 9 ranged from 245 to 337 mm., with an average of 286·2mm. On 13th October, of 31 taken in five hauls, in from 12–15 fathoms (IV.), 26 ranged from 72 to 121 mm., with an average size of only 92·9mm.; the other five varied from 219 to 284 mm., the average being 260·8mm.

On 23rd October, 20 cod were captured in from 36½ to 49 fathoms (V.), of which 14 ranged from 77 to 112 mm., with an average of 91·6mm.; 5 ranged from 272 to 320 mm., and, combined with three codlings taken the next day in 60 fathoms (ranging from 264–275 mm.), gave an average size of 282·0mm. There was also one at 450mm., which is omitted from the above Table.

It will be observed from the above that quite small codling were occasionally obtained in water 23–27 and 36½–49 fathoms deep.

The above measurements may be combined to some extent as follows:—

		No.	Range, mm.	Difference, mm.	Average Size, mm.
21, 22 Sept.,	1st Series -	9	68–124	56	88·6
9–23 Oct.,	„ „ -	51	72–157	85	95·2
Sept.,	2nd Series -	16	209–296	87	255·5
Oct.,	„ „ -	22	219–337	118	278·9

The combination of all the hauls gives an average size for the first series of 94·1mm., or 3¾ inches, and for the second series 269mm., or 10⅝ inches, apparently indicating an annual increment of growth of 174·9mm., or 6⅞ inches, which is probably too much. Owing to the absence of the second series in the December hauls of the trawlers, a similar comparison cannot be made with them, but in the October hauls the differences between the averages of the two series were, respectively, 130·8, 175·8, and 157·3 mm., the mean for the latter two being 162·1mm. In all instances the numbers in the second series were small.

(2). *Hauls in the Moray Firth.*

The cod caught in hauls made in the Moray Firth by the "Garland" in May, June, November, December, and January, and by trawlers in October, November, and December, were also dealt with. Hauls were made with shrimp-net as follows:—I., 25th May, Dornoch Firth, 4 fathoms. II., 9th June, Cromarty Firth, 1–3 fathoms. III., 19th June, Dornoch Firth, 1–3 fathoms. IV., 11th November, Cromarty Firth, 8–9 fathoms. V., 11th November, outside Cromarty Firth, 12 fathoms. VI., 24th December, Dornoch Firth, 10 fathoms. VII., 10th January, Cromarty Firth, 6–7 fathoms. The cod got in two hauls of the ordinary trawl-net were also measured, viz., VIII., 9th June, Cromarty Firth, 8–10 fathoms. IX., 30th November, Cromarty Firth, 7½–8 fathoms.

The measurements are grouped in centimetres as follows:—

	2	3	4	5	6	7	8	9	10	11	12	13	14
I.	..	..	..	..	..	..	..	..	..	..	1	1	..
II.	..	8	7	..	..	..	..	..	..	..	..	..	..
III.	3	27	30	2	..	..	..	..	..	..	..	..	..
IV.	..	..	..	..	..	..	1	..	..	..	..	..	3
V	..	..	..	..	..	..	2	4	1	1	1	2	..
VI.	..	..	..	..	..	..	1	..	2	2	2	1	1
VII.	..	..	..	..	..	..	2	1	1	..	3	2	2
VIII.	..	..	..	..	..	..	..	..	..	..	..	..	1
IX.	..	..	..	..	..	1	..	1	2	1	1	..	3

	15	16	17	18	19	20	21	22	23	24	25	26	27
I.	1	1	1	..	..	..	..	..	..	..	..	..	..
II.	..	..	..	..	..	..	..	..	..	..	..	..	..
III.	..	..	..	..	..	..	..	..	..	..	..	..	..
IV.	1	..	1	..	..	..	..	..	1	..	..	..	..
V.	..	..	..	..	..	..	..	..	..	..	..	..	..
VI.	1	1	..	1	..	..	..	..	..	1	..	..	..
VII.	2	1	1	3	2	..	..	..	..	..	1	1	2
VIII.	1	2	5	2	3	1	3	2	1	1	..	2	..
IX.	4	3	4	3	4	1	..	1	..	1	2	..	1

	28	29	30	31	32	33	34	35	36	37	38	39	40
VII.	1	3	3	2	2	2	1	2	..	..	..	..	..
VIII.*	..	..	1	..	..	..	..	..	..	..	1	..	..

* In this haul of 9th June there was one cod 454mm.

On 25th May the five cod caught in the small-meshed net in 4 fathoms varied from 120 to 170 mm., with an average size of 148·6mm., or 5⅞ inches. They were obviously fish spawned in the previous year. Those of 1900 were, at this date, represented by a single specimen 34mm.

long, got in a few feet of water in the Dornoch Firth. On 9th June a haul with a small shrimp-net, in 1–3 fathoms, caught 15 cod, from 31 to 48 mm., with an average size of 39·7mm., or $1\frac{9}{16}$ inches. A haul with the ordinary net (VIII.) in 8–10 fathoms, on the same day, gave 27 cod, of which 24, ranging in size from 141 to 268 mm., appear to belong to one series, with an average size of 197·8mm., or $7\frac{13}{16}$ inches. The difference between the largest and the smallest in this group is 127mm., or a little over 5 inches. There was another specimen at 302mm., which probably belongs to a third series; if included it would extend the range to 161mm., or $5\frac{11}{16}$ inches.

On 19th June a haul (III.) in 1–3 fathoms yielded 62 cod, measuring from 26mm., or 1 inch, to 51mm., or 2 inches, the range thus being 25mm., and the average size was 39·6mm., or $1\frac{9}{16}$ inches, the same as on 9th June.

On 11th November a haul (IV.) in 8–9 fathoms, and another in 12 fathoms (V.), gave 18 cod; 17 measured from 82 to 170 mm., and probably belong to the same group, the average size being 116·4mm., or about $4\frac{9}{16}$ inches. The other measured 232mm.

On 30th November a haul (IX.) in $7\frac{1}{2}$–8 fathoms yielded 33 cod, of which 28 apparently belonged to one series, ranging from 78 to 200 mm., with a difference of 122mm. and an average size of 156·5mm., or about $6\frac{3}{16}$ inches. This haul, however, was made with the ordinary trawl, and many of the smaller fishes would escape. The average is therefore no doubt too high.

On 24th December, in 10 fathoms (VI.), 12 cod were taken ranging from 83 to 187 mm., with an average size of 130·7mm., or $5\frac{1}{4}$ inches. There was another at 240mm.

On 10th January, in 6–7 fathoms (VII.), 41 cod were taken, of which 21 measured from 84 to 197 mm., with a range of 113mm., and an average size of 142·1mm., or $5\frac{5}{8}$ inches. The presence in January of cod so small as 84mm., or about $3\frac{5}{16}$ inches, in length is interesting; the next was 89mm., and another was 91mm. A second series was composed of 20 fishes, from 255 to 355 mm., with a range of 100mm. and an average size of 307·6mm., or about $12\frac{1}{8}$ inches.

In these hauls of the "Garland" the numbers are too small to allow of much stress being laid upon the averages. The brood spawned in the spring ranged from 26 to 51 mm. in June, with an average size of 39·6mm. In November the mean average of the two hauls, on 11th and 30th, comprising 45 fishes of this series, was 144·5mm., or 104·9mm. ($4\frac{1}{8}$ inches) greater, and this would represent the amount of growth in the five intervening summer and autumn months. For the reason above stated, the average of this series in the haul of 30th November is too high. The average of the haul on 11th November (116·4) is probably nearer the truth, and it would represent a growth of 76·8mm., or 3 inches, in the period, or about ·5mm. daily. The mean average of the two hauls on 24th December and 10th January is 138·0mm., which would represent a growth from June of 98·4mm., or $3\frac{7}{8}$ inches, in the six and a half months, and of 21·6, or about $\frac{7}{8}$ of an inch, in the seven and a half weeks from 11th November.

From the paucity or absence of the second series in most of the hauls, strict comparison of the averages in this case is also a little doubtful. Those of the hauls of 9th June and January 10th show an apparent growth in the seven months of 109·8mm., or $4\frac{5}{8}$ inches. Comparison between the first and second series shows an apparent growth for the whole year in the June series of 158·1mm., or about $6\frac{1}{4}$ inches; and in the January series of 165·5mm., or $6\frac{1}{2}$ inches. This agrees very closely with the yearly amount of growth deduced from the hauls in

Aberdeen Bay in October and November, the mean of which was 162·1mm., or 6⅜ inches. The mean for these hauls of the "Garland" in June and January is 161·8mm., or only ·3mm. less. On the other hand, the yearly increment of growth deduced from the "Garland's" hauls in Aberdeen Bay was 166·9 in September, and 183·7 in October, the mean being 174·9mm., or 6⅞ inches.

In a haul made by the trawler "St. Andrew," with the usual arrangement of small-meshed netting, on 5th November, in 7–10 fathoms, in Dornoch Firth, a number of cod were taken, and also in a haul with the ordinary net on the following day in 9–11 fathoms. The measurements are arranged in centimetre groups in the following Table:—

Nov.	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
5th . .	.	1	3	6	7	8	14	14	11	10	6	5	5	5	4	.
5th . .	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	4

Nov.	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
5th . .	2	2	3	2	3	3	.	2	1	.	.	.	.	.		.
6th . .	2	4	4	4	9	16	17	26	34	34	40	32	26	15	12	4

Nov.	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53
5th . .	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
6th . .	1	2	4	1	1	1	.	1	2	2	4	4	2	4	2	3

Nov.	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69
5th . .	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
6th . .	1	2	1	1	1	1	.	.	.	1	1	.	1	.	1	.

Nov.	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85
5th . .	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
6th . .	.	.	1	1	2	2	.	1	.	1	1	.	.	1	.	1

Nov.	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101
*5th .	.	.	.	.	.	.	2	.	.	.	.	.	.	.	1	.
6th . .	.	.	.	.	.	1	.	1	.	.	.	1	.	1	1	.

* Another one in this haul measured about 1125 mm.

In the haul on the 5th 100 cod, from 79 to 209 mm., appeared to form a first series, but the termination might perhaps have been at 203mm. In the former case the range is 130mm., and the average size 138mm., or 5½ inches; in the latter case the range is 126mm., and the average size 137·3mm. The second series comprised 18 fish from 222 to 308 mm., with a range of 86mm. and an average size of 260·4mm., or 10¼ inches. The next size was about 762mm., or 30 inches; there were two at 36¼ inches (920mm.) and one at 39½ inches (1004mm.). The small cod in this instance, and in the following haul also, were found

to be feeding on young herrings; in some cases their stomachs were packed with three or four of them. The young cod in numbers no doubt follow the shoals of small herrings when they leave the bottom, and this may account to some extent for the somewhat varying sizes of codling captured in the trawl.

The haul on the 6th was made without the small-meshed net around the bag, and the first series is therefore represented only by one or two stragglers (Pl. XVI.).. The smallest measured respectively 195, 209, 211, 215, 216, 219 mm. The first, and perhaps the second, belong to the first series. The series represented may, however, be taken as commencing at 209mm., and it extends to 381mm., the range being thus 172mm. or $6\frac{3}{4}$ inches, and the average size is 311·6mm. or $12\frac{1}{4}$ inches. The number of fish in the series was 282. If the 18 fish belonging to this series taken on the previous day be included, the mean average is 308·2mm. or $12\frac{1}{8}$ inches. The difference between the averages of the first and second series in these hauls is 170·2mm. or $6\frac{1}{16}$ inches, which represents the annual increment of growth, and is 8·4mm. more than that deduced from the "Garland" averages. The difference between the smallest fish of the first and the second series is 130mm., and the difference between the largest in each series is 172mm.

There is more difficulty in assigning the limits of the series among the remaining cod. The next group, beginning at 390mm., appears to extend to 59·5cm., the next largest fish increasing 63·5cm. In this case the series, comprising 41 cod, has a range of 205mm. or $8\frac{1}{8}$ inches, and an average size of 490mm. or $19\frac{1}{4}$ inches. The difference between this and the mean average for the previous series, or the annual increment of growth, is 181·8mm. or $7\frac{1}{8}$ inches. The figures indicate that cod approaching their third year of age (about 32 months old) have the above average size, and may vary from about $15\frac{1}{4}$ inches to about $23\frac{1}{2}$ inches at this period. The number of specimens is, however, too small to enable this statement to be made with certainty, and the average is probably too low.

Two other series at least appear to be represented, as the Table shows, but they are too scanty to permit any average size to be assigned.

A haul made on 25th December in 12 fathoms in Dornoch Firth, by the "Star of Hope," yielded 50 cod. Of these the first series comprised 48 fish, from 88mm. to 208mm., with a range of 120mm. and an average size of 136·9mm. or $5\frac{3}{8}$ inches. This is 1·1mm. below the average of the 100 specimens taken by the "St. Andrew" on 5th November. One cod measured 288mm., and another 468mm.

3. *Hauls in Deep Water.*

In the two hauls with the small-meshed net made by the "St. Andrew" in deep water on 31st August and 4th September (*see* p. 155) no very young cod were taken. In some other hauls the codling were measured in inches, but their numbers were inconsiderable. In the hauls made by the same vessel off Fair Isle in October the codling captured were measured by Mr. Dannevig. In two hauls made with the small-meshed net around the cod-end, one on 16th and one on 19th October, in 65 fathoms, only two young cod were taken, one at 88mm. on the 16th and, one at 122mm. on the 19th. The observations show that, as with the whiting, the year's cod, although not absent from the deep-water grounds, are not abundant there; and they may, of course, have been captured in mid-water as the net was being shot or hauled. I have tabulated in centimetre groups the cod caught in other hauls combined, between the 16th and the 20th October, as follows:—

20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
1	2	..	6	6	3	13	5	15	25	16	22	20	27	15
35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
17	30	38	34	48	42	48	32	41	26	16	14	14	20	8
50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
7	8	8	13	15	8	9	4	9	6	2	10	4	4	9
65	66	67	68	69	70	71	72	73	74	75	76	77	78	79
1	4	4	14	2	3	9	2	3	4	7	11	5	4	2
80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
1	2	4	7	1	3	4	8	..	3	6	2	7	..	5
95	96	97	98	99	100	101	102	103	104	105	106	107	108	109
4	2	4	..	1	1	1	2	1	..	..	..	..	1	1

It will be observed from the above that the sizes do not form symmetrical groups, and this is also shown when they are plotted out in graphic form, the curve being very irregular (Pl. XVI.). A series culminates about 40cm., but to include all from 23cm. (9 inches) on one side to about 50cm. (19¾ inches) on the other, would be to give a range too extensive; and the depression about 34–35 cm. suggests that a series may terminate there. Treatment of the separate hauls is not more satisfactory, and the only conclusion that can be drawn from the measurements is that a group appears to have its culmination or average about 15¾ inches.

5. Solway Firth.

In various hauls with a shrimp-net in 2–4 fathoms in the Solway Firth young cod were captured, the measurements of which are given in the following Table :—

[Table.

Date.	No. of Fish.	Size.			
		Range.	Difference.	Average.	
1899.		Mm.	Mm.	Mm.	Inches.
1st August .	5	55-81	26	62·4	2 7/8
27th Sept. .	14	68-123	55	101·8	4
10th October .	9	95-126	30	116·1	4 9/16
1900.					
30th July .	59	47-86	39	65·0	2 9/16
30th August .	12	63-113	50	89·9	3 9/16
28th Sept. .	12	70-105	35	93·0	3 11/16
31st October .	6	70-118	48	97·3	3 13/16
27th November	8	77-126	49	133·2	5 1/4
30th December	5	97-182	85	144·2	5 11/16

The numbers are small in nearly all these hauls, and the averages cannot therefore be regarded as more than approximate. Yet they agree fairly well with those for the East Coast, and show the progressive growth of the young cod at the dates mentioned.

I append a Table showing the particulars concerning most of the hauls, and comprising the measurements of cod :—

Date and Place.	Depth.	No. of Fish.	Size.				Apparent Annual Growth from preceding Series.	
			Range.	Difference.	Average.			
Aberdeen Bay.	Fms.		Mm.	Mm.	Mm.	Inches.	Mm.	Inches.
8 *Oct.*	12-14							
A Series . .		42	80-166	86	116·5	4 9/16	...	...
B ,, . .		7	199-291	92	247·3	9 3/4	130·8	5 1/8
31 *Oct.*	8-10							
A Series . .		195	88-183	95	120·4	4 3/4	...	...
B ,, . .		4	263-329	66	296	11 11/16	175·8	6 15/16
1 *Nov.*	12-15							
A Series . .		73	83-172	89	118·5	4 11/16	...	...
B ,, . .		9	216-325	109	275·8	10 7/8	157·3	6 3/16
31 *Oct.*, 1 *Nov.* **Average.**								
A Series . .		268	83-183	100	119·9	4 11/16	...	..
B ,, . .		13	216-329	113	282	11 1/8	162·1	6 3/8

Date.	Depth.	No. of Fish.	Size.				Apparent Annual Growth from preceding Series.	
			Range.	Difference.	Average.			
ABERDEEN BAY—*continued.*	Fms.		Mm.	Mm.	Mm.	Inches.	Mm.	Inches.
9 *Nov.*	9							
A Series . .		6	87-131	44	105·5	4⅛	...	...
17 *Dec.*	8-15							
A Series . .		38	106-162	56	131·1	5 5/16	...	...
18 *Dec.*	8							
A Series . .		43	82-119	37	97·2	3 13/16	...	...
19 *Dec.*	5-12							
A Series . .		155	75-183	110	103·8	4⅛	...	...
19 *Dec.*	6-8							
A Series . .		20	79-111	32	93·8	3 11/16	...	...
21 *Dec.*	7							
A Series . .		114	84-188	104	111·7	4⅜	...	...
Dec. **Average.**								
A Series . .		370	75-188	113	107·7	4¼	...	...
21-25 *Sept.*	5-27							
A Series . .		9	68-124	56	88·6	3½	...	...
B ,, . .		16	209-296	87	255·5	10 1/16	166·9	6 9/16
9 *Oct.*	12-16							
A Series . .		11	83-157	74	105·0	4⅛	...	...
B ,, . .		9	245-337	92	286·2	11¼	181·2	7⅛
13 *Oct.*	12-16							
A Series . .		26	72-121	49	92·9	3⅝	...	...
B ,, . .		5	219-284	65	260·8	10¼	167·9	6⅝
23 *Oct.*	36¼-49							
A Series . .		14	77-112	35	91·6	3⅝	...	...
B ,, . .		5	272-320	48	290·4	11 7/16	198·8	7 13/16
24 *Oct.*	60							
B Series . .		3	264-275	11	268·0	10 9/16	...	...
Oct. **Average.**								
A Series . .		51	72-157	85	95·2	3¾	...	...
B ,, . .		22	219-337	118	278·9	11	183·7	7¼

Date.	Depth.	No. of Fish.	Size.				Apparent Annual Growth from preceding Series.	
			Range.	Difference.	Average.			
Moray Firth.	Fms.		Mm.	Mm.	Mm.	Inches.	Mm.	Inches.
25 *May.*	4							
B Series . .		5	120-170	50	148·6	$5\frac{7}{8}$	...	...
9 *June.*	1-3							
A Series . .		15	31-48	17	39·7	$1\frac{9}{16}$	...	...
9 *June.**	8-10							
B Series . .		24	141-268	127	197·8	$7\frac{13}{16}$	158·1	$6\frac{1}{4}$
19 *June.*	1-3							
A Series . .		62	26-51	25	39·6	$1\frac{9}{16}$	...	...
11 *Nov.*	8-12							
A Series . .		17	82-170	88	116·4	$4\frac{9}{16}$	...	...
30 *Nov.**	$7\frac{1}{8}$-8							
A Series . .		28	78-200	122	156·5	$6\frac{9}{16}$	...	...
24 *Dec.*	10							
A Series . .		12	83-187	104	130·7	$5\frac{1}{4}$	...	...
10 *Jan.*	6-7							
A Series . .		21	84-197	113	142·1	$5\frac{5}{8}$	...	—
B ,, . .		20	255-355	100	307·6	$12\frac{1}{8}$	165·5	$6\frac{1}{2}$
5 *Nov.*	7-10							
A Series . .		100	79-209	130	138	$5\frac{1}{2}$	...	...
B ,, . .		18	222-308	86	260·4	$10\frac{1}{4}$	130·4	$5\frac{5}{16}$
6 *Nov.**	9-11							
B Series . .		282	209-381	172	311·6	$12\frac{1}{4}$	...	...
C ,, . .		41	390-595	205	490	$19\frac{1}{4}$	181·8	$7\frac{1}{8}$
Nov. **Average.**								
A Series . .		100	79-209	130	138	$5\frac{1}{2}$	...	...
B ,, . .		300	209-381	172	308·2	$12\frac{1}{8}$	170·2	$6\frac{11}{16}$
C ,, . .		41	390-595	205	490	$19\frac{1}{4}$	181·8	$7\frac{1}{8}$
25 *Dec.*	12							
A Series . .		48	88-208	120	136·9	$5\frac{3}{8}$	...	...

* Ordinary trawl-net.

SUMMARY.

It is comparatively an easy matter to determine the mean age of the cod in the three series dealt with above. The cod spawns on the East Coast in February, March, April, and May, and principally in March; a few spawning fish may also be found in January and June.* The great majority of the eggs probably hatch about the end of March and early part of April, which may be taken as the period from which to date the average age of the season's brood. The average size of the season's cod caught on 9th and 19th June, in 1–3 fathoms, in the Moray Firth, was 39·6mm., or just over 1½ inches, which would represent the amount of growth in a little more than two months. At this time they ranged in size from 1 inch to 2 inches. On November 11th they were found in the same locality in 8–12 fathoms, ranging from 3½ to nearly 6¾ inches, the mean size being a little over 4½ inches. Much the same range of size was found on 24th December, the largest being 7⅜ inches, the smallest 3¼ inches, and the mean size was 5¼ inches. On 10th January, in 6–7 fathoms, some were found as small as 3 5/16 inches, the largest of the series being 7¾ inches, and the average was 5⅝ inches. These fish were caught by the small-meshed net of the "Garland"; those caught by the trawlers gave somewhat higher averages. Thus, on 7th November, in 7–10 fathoms, they varied in size from 3⅛ to 8¼ inches, with a mean size of 5½ inches. On 25th December, in 12 fathoms, they ranged from 3½ to 8¼ inches, and had an average size of 5⅜ inches.

On 8th October, in Aberdeen Bay, the young cod of the year got in 12–14 fathoms ranged between 3¼ and 6½ inches, the average size being 4 9/16 inches. At the end of the month they varied from 3½ to 7¼ inches, the mean size being 4 11/16 inches. A little after the middle of December they were found in 5–12 fathoms from 3 to 7⅜ inches, the average size being 4¾ inches.

The very considerable range of sizes in these cases—the difference between the smallest and the largest being almost equal to the mean size for the group—is only partly accounted for by the range of the spawning season; it is equally due to difference in the rate of growth of individual fishes and to migration.

It may be said, therefore, that the cod hatched about the beginning of April attain an average size of about 4¾ inches in October, and that the season's brood at this time vary from 3 inches to about 7½ inches in length.

The increment of growth in a whole year at this period is shown by the difference between the average size of the season's fish and of those of the previous year. It varies in the hauls represented in the Table from 5⅛ to 7 13/16 inches, but the extremes depend upon the comparison of very few fishes in the second series. The mean of the ten cases in which comparison can be made is 167·2mm., or a little over 6½ inches, and this may be taken as approximately representing the increase in the length of a cod in a year at this period of their lives, and it agrees very well with the growth of the season's brood to a length of about 5 inches in December, when they are eight or nine months old.

The next series or generation—fish of the preceding year—had an average size in June of about 7¾ inches, and a range from 5½ to about 10½ inches. In September the average size was about 10 inches, and the range from 8¼ to about 11½ inches. In October they measured on the average about 11 inches, and ranged from about 8 to 13 inches. In January the mean size was a little over 12 inches, and the range from

* *Tenth Ann. Rep. Fishery Board for Scotland*, Part iii., p. 233.

10 to 14 inches. According to the rate of growth deduced from a comparison of the mean averages of the two series or generations throughout, these fishes should reach an average size of a little over 13 inches in the following March or April, when they would be two years old.

The third series or generation (C) was only represented by 41 fishes caught on 9th November. The average size was 19¼ inches, and they ranged from about 15¼ to 23½ inches. The annual increment of growth from the previous year's fish, deduced from a comparison of the above average with the average of the preceding series (B), is 7⅛ inches.

The average size at which the cod becomes mature has not perhaps been yet determined with precision, but it has been shown by myself that the male may reach maturity when about 20, and the female be nearly mature when about 21 inches in length.* Holt, with more abundant material, places the minimum size of the ripe male at 22 inches, and that of the ripe female at 26½ inches; † and there is no doubt the great bulk do not spawn until a little larger. Since the cod above mentioned were about two years and seven months old when they were caught, it is evident that some of them would not only reach but exceed the minimum size of maturity in the next spawning season. It seems equally clear that the majority would not do so, and it thus appears that while some cod, especially males, may spawn when three years old, most of them do not begin spawning until they are four years of age. On the assumption that the rate of growth above indicated (7⅛ inches) was maintained, the average size of cod three years and seven months old in November would be a little over 26 inches; and in the following spawning season when four years of age, their mean size would be probably between 27 and 28 inches.

I may mention that a codling I placed in the large tidal pond at the Marine Laboratory, Bay of Nigg, increased from 11¾ inches on 28th August last to 12⅞ inches on the 26th September. The increase in length was thus at the rate of 1mm. daily, and it was no doubt greater than it would have been in the sea under ordinary conditions, because the fish was surfeited with mussels so that its belly was abnormally distended.

* *Tenth Ann. Rep. Fishery Board for Scotl.*, Part iii., p. 239.
† *Jour. Mar. Biol. Assoc.*, iii., p. 80.

EXPLANATION OF PLATES.

IX-XVI.—Diagrams representing the measurements of different groups or annual series of the Norway Pout, the Whiting, Haddock, and Cod.

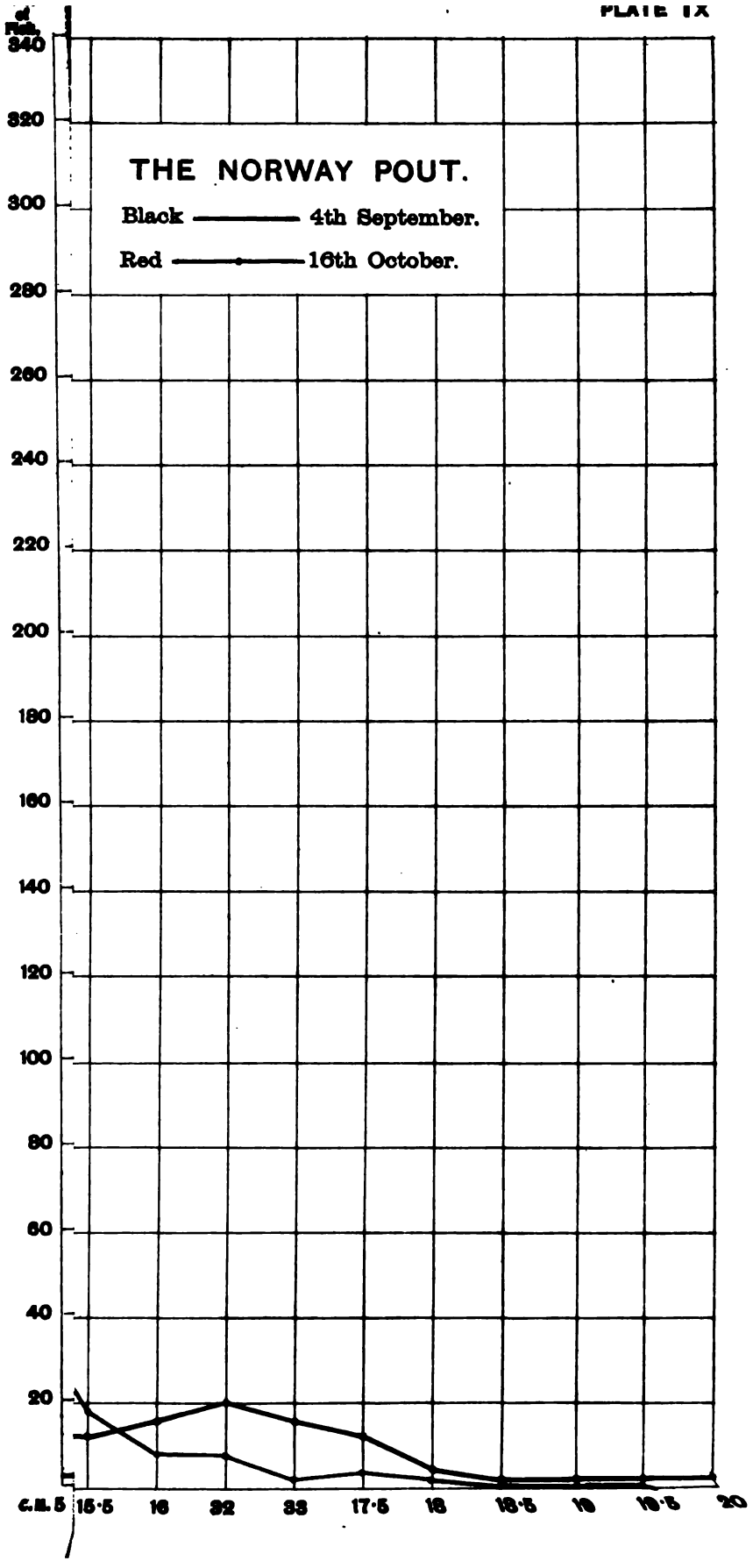
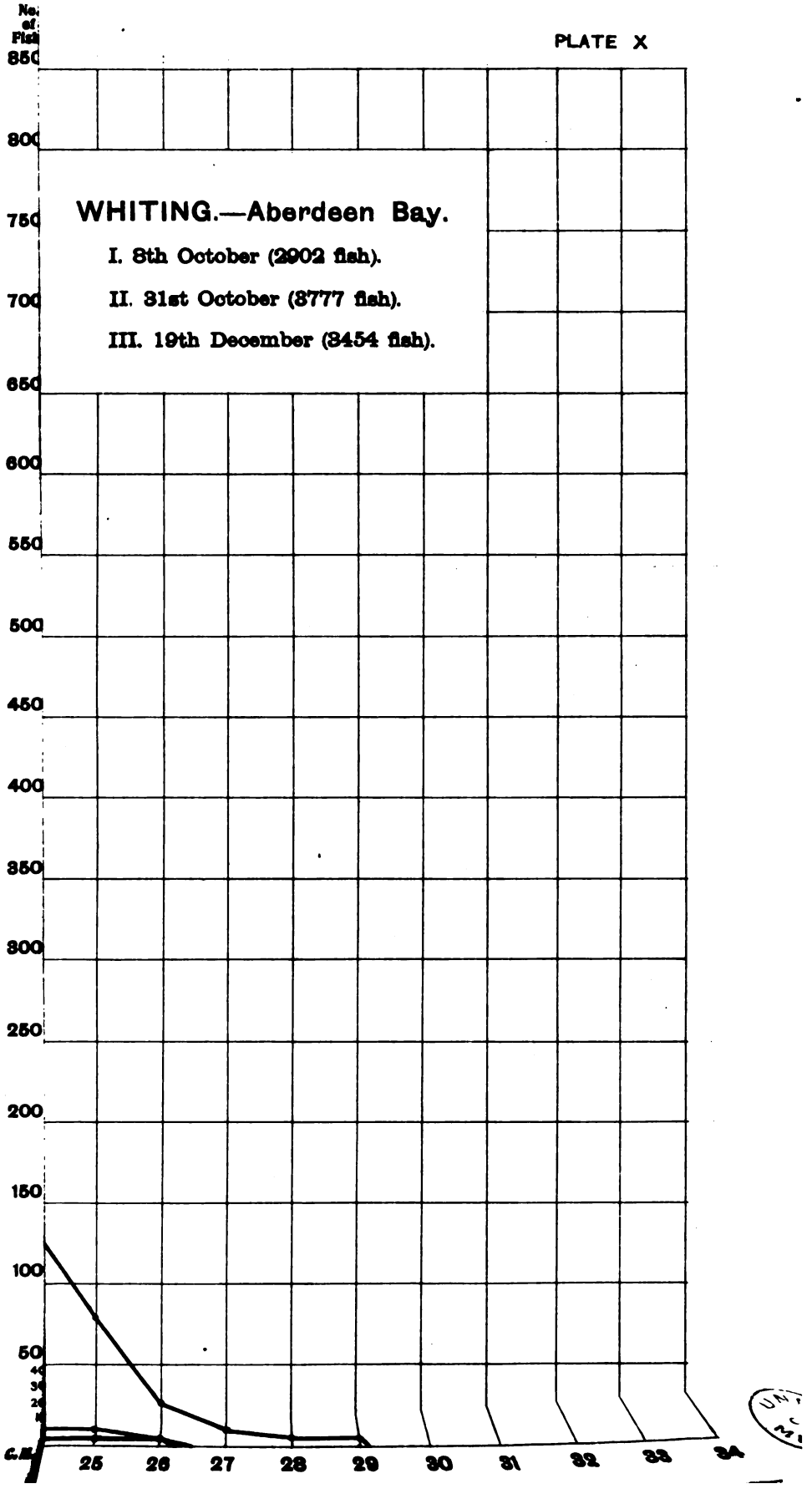

of Fish.
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
THE NORWAY POUT.
Black 4th September.
Red 16th October.
c.m. 5
15·5
16
32
33
17·5
18
18·5
19
19·5
20

PLATE X



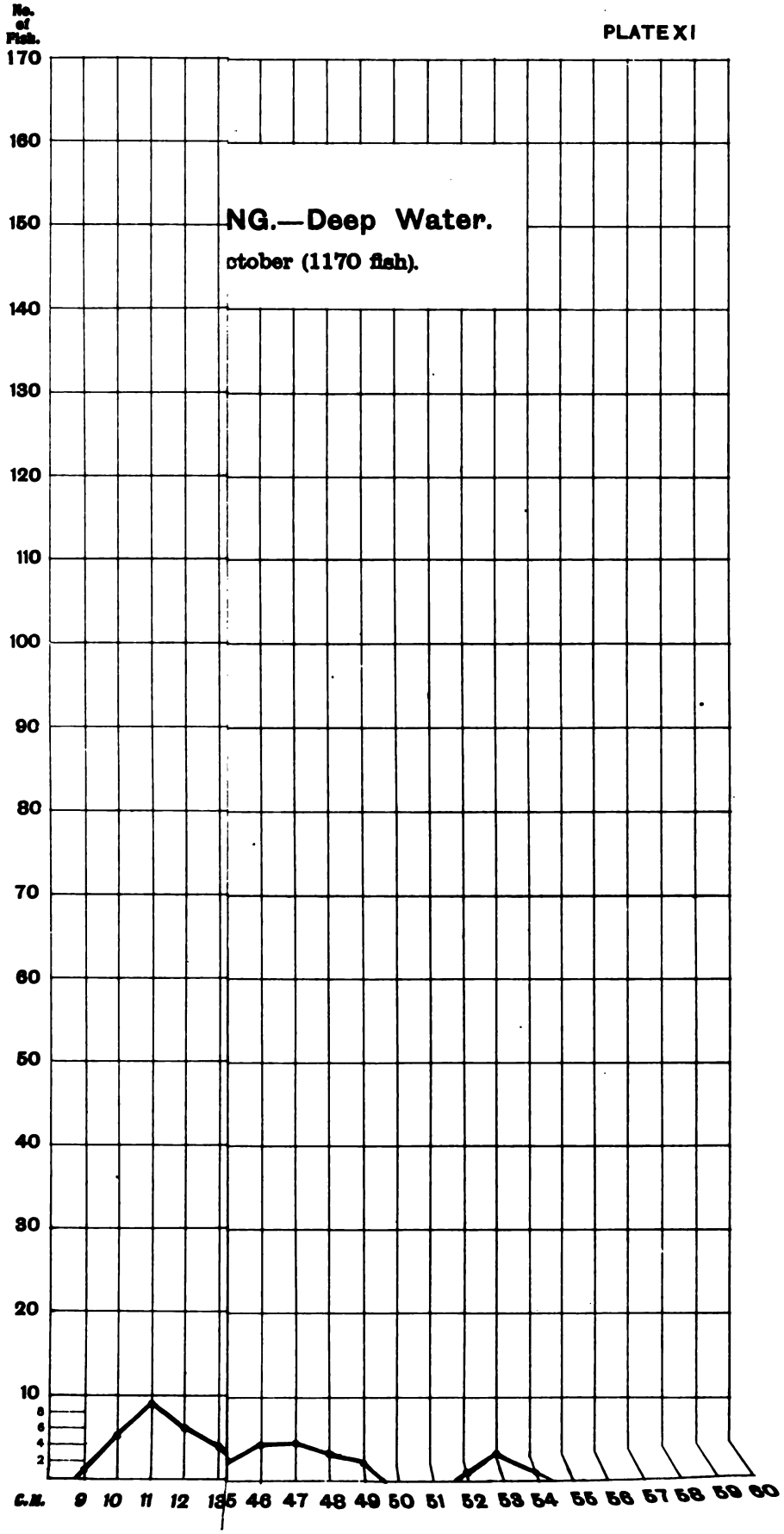
WHITING.—Aberdeen Bay.

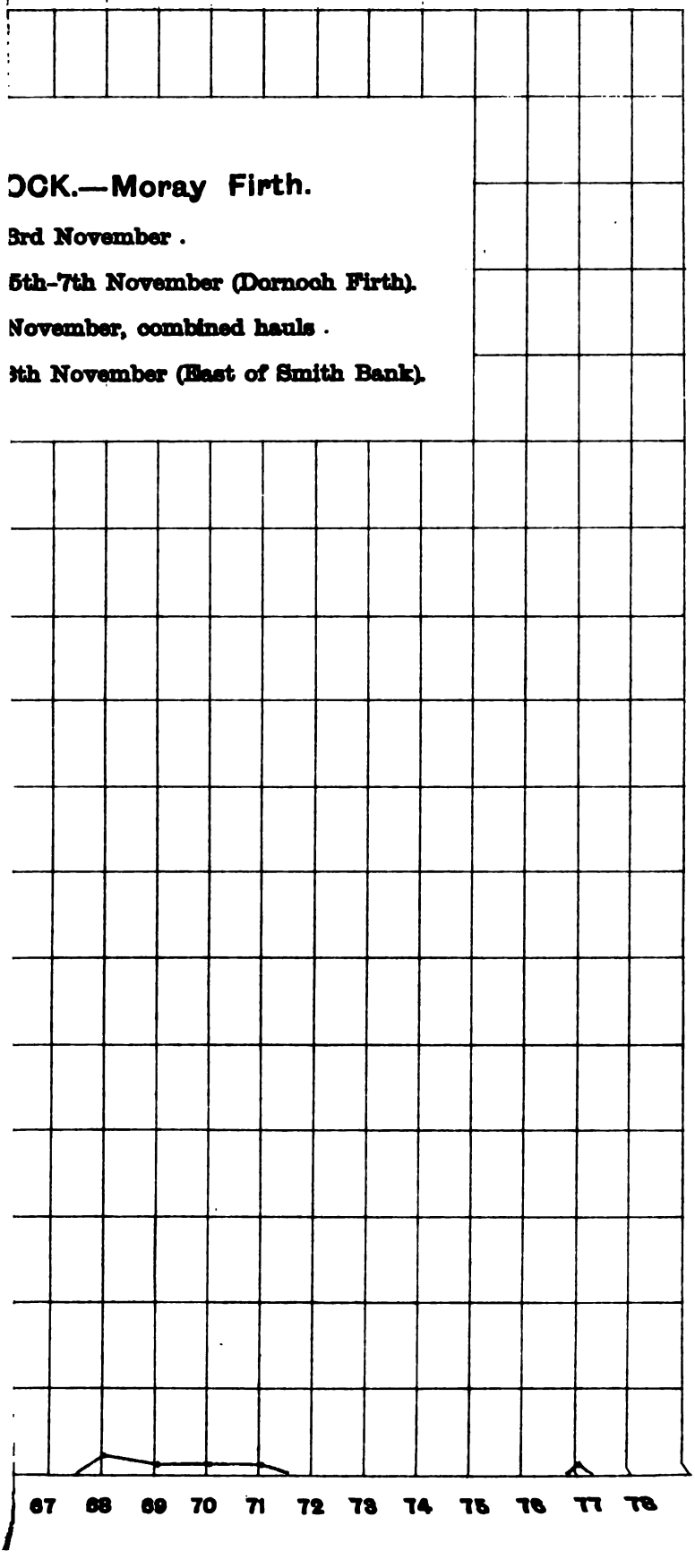
I. 8th October (2902 fish).

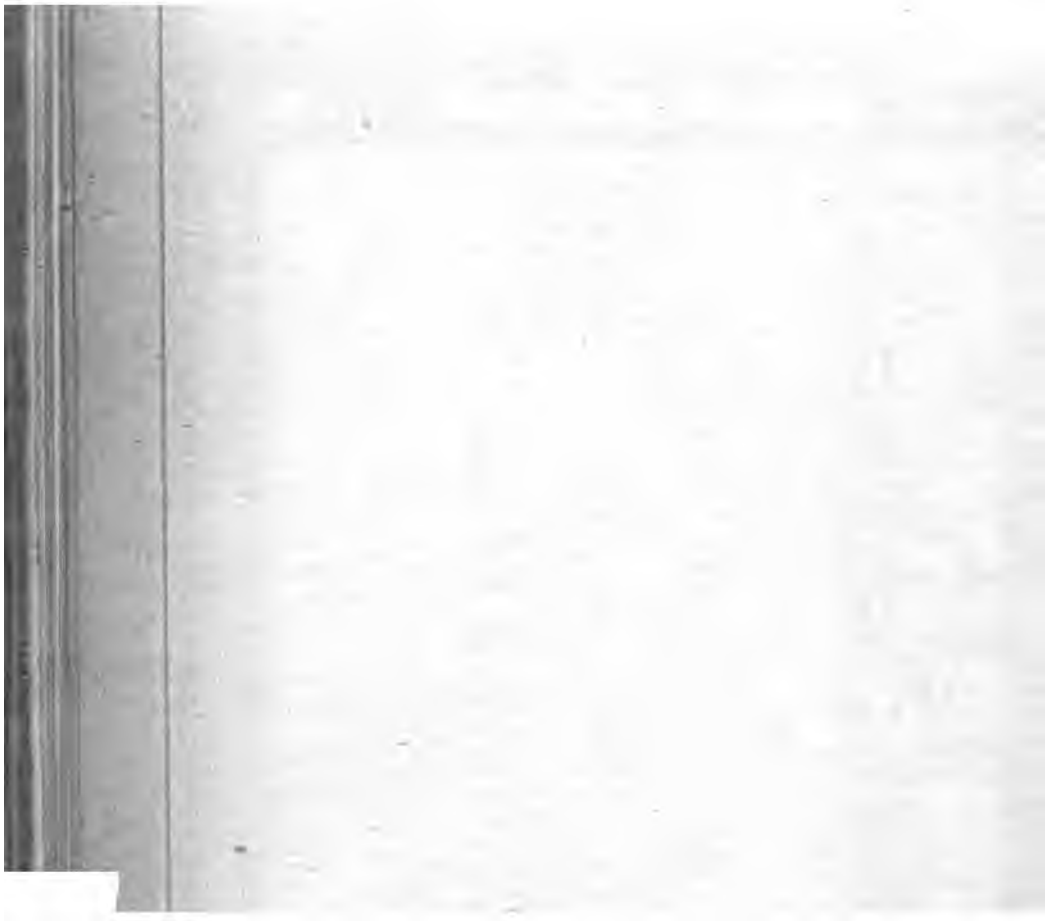
II. 31st October (3777 fish).

III. 19th December (3454 fish).

PLATE XI


No. of Fish.
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
8
6
4
2
NG.—Deep Water.
ctober (1170 fish).
C.M. 9 10 11 12 13 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60


OCK.—Moray Firth.
3rd November .
5th-7th November (Dornoch Firth).
November, combined hauls .
3th November (East of Smith Bank).
67
68
69
70
71
72
73
74
75
76
77
78



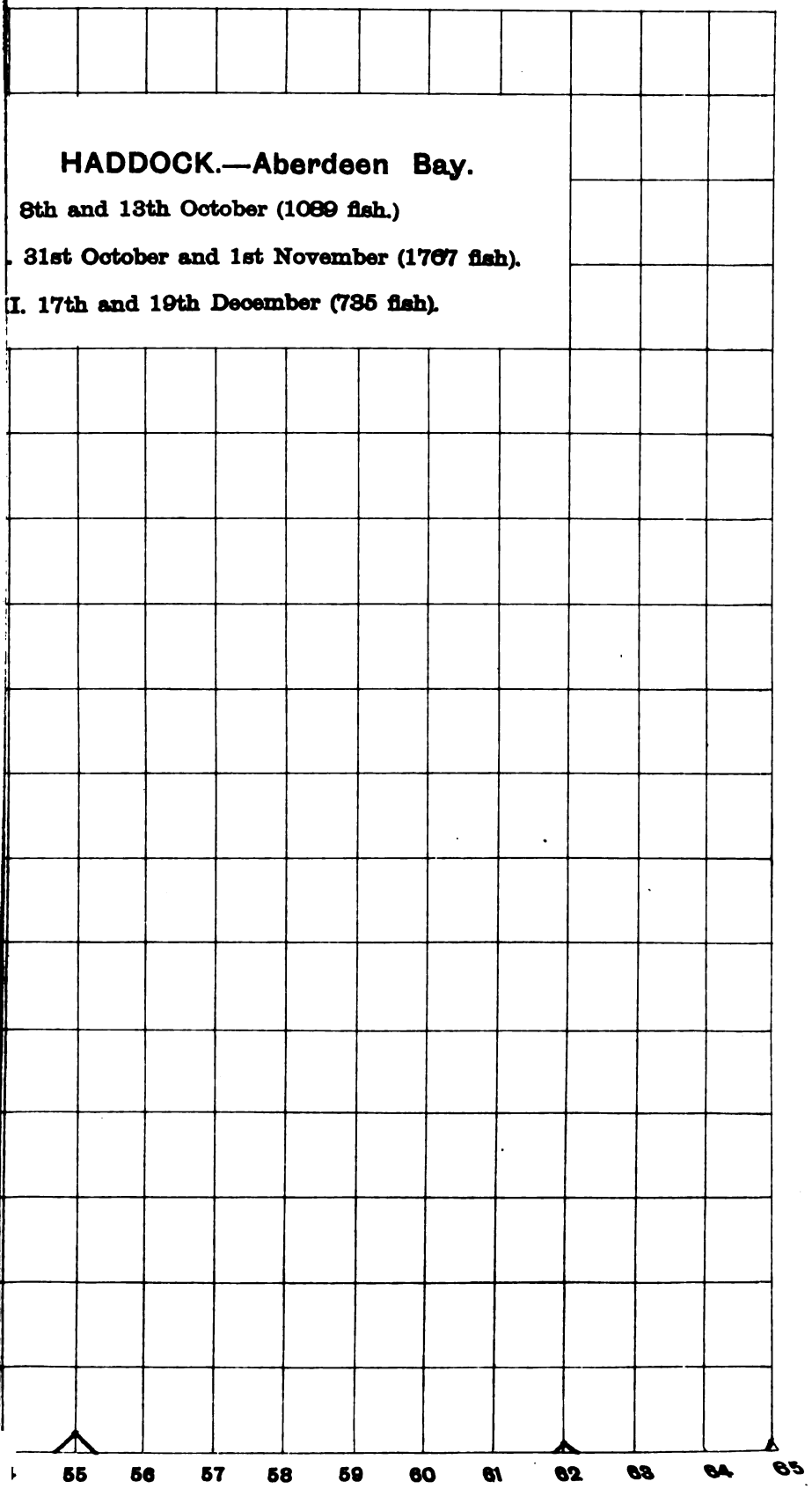
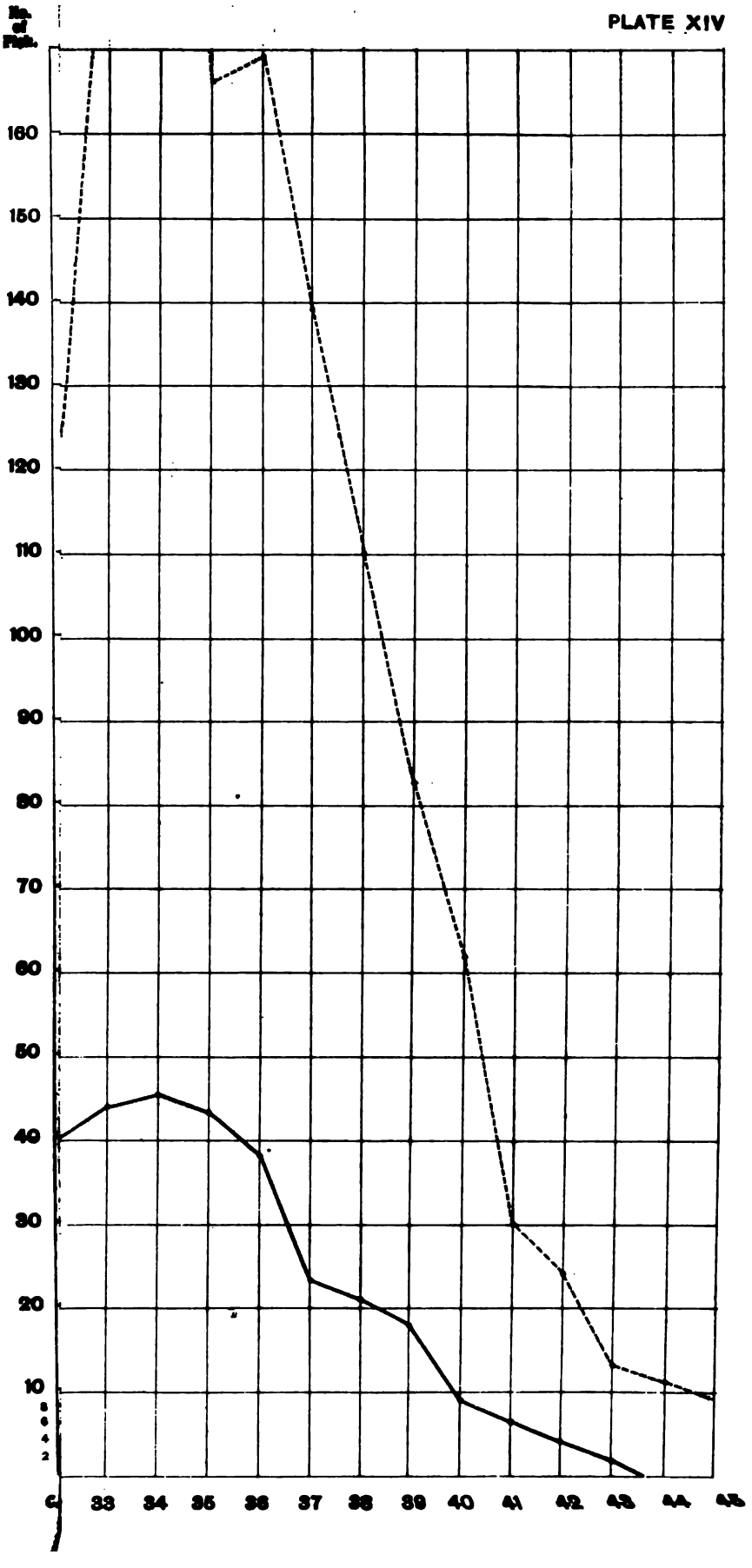
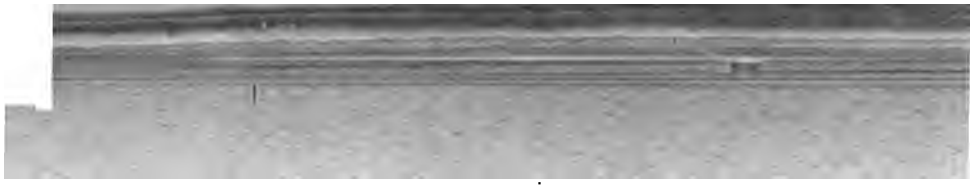
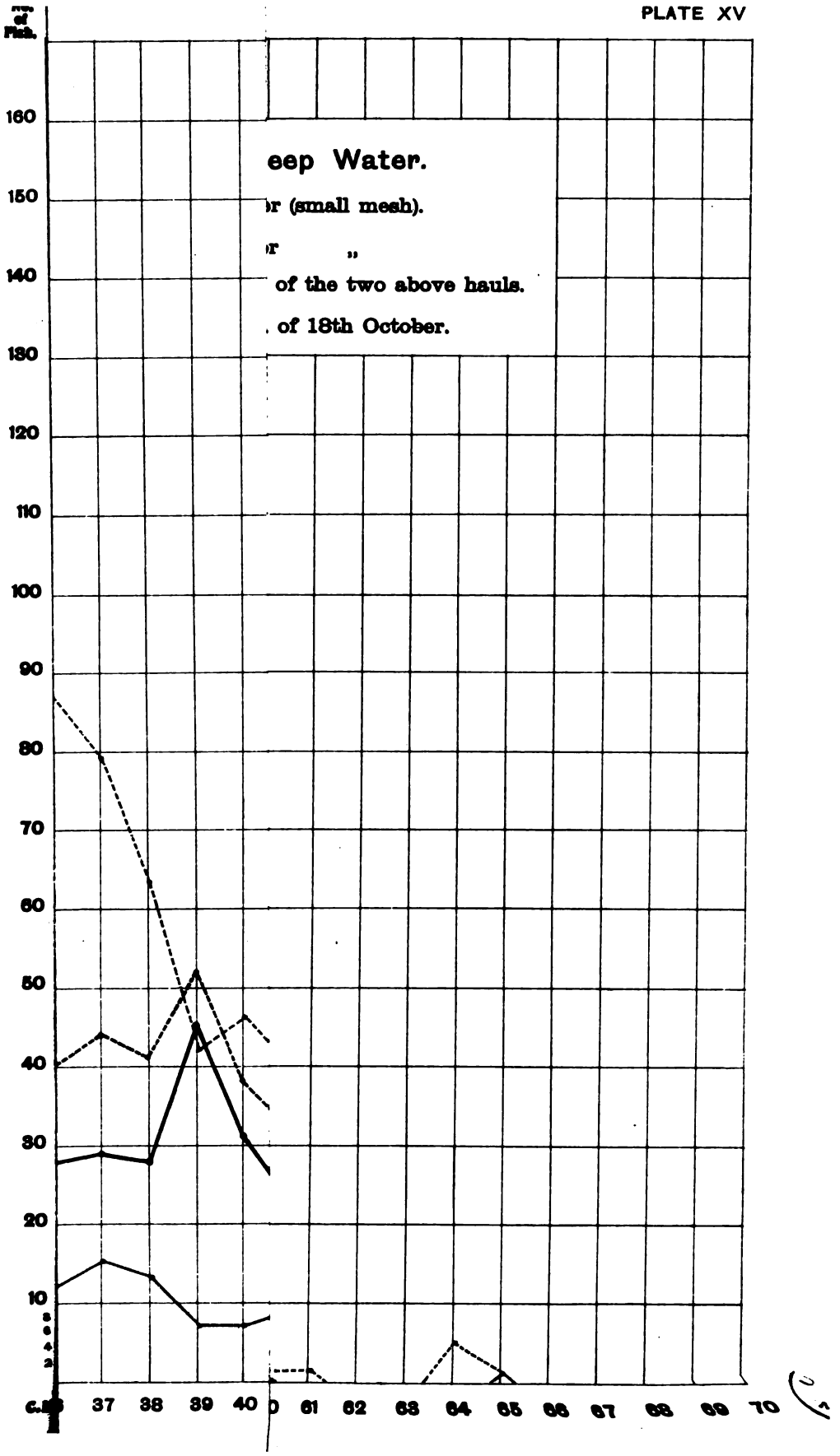
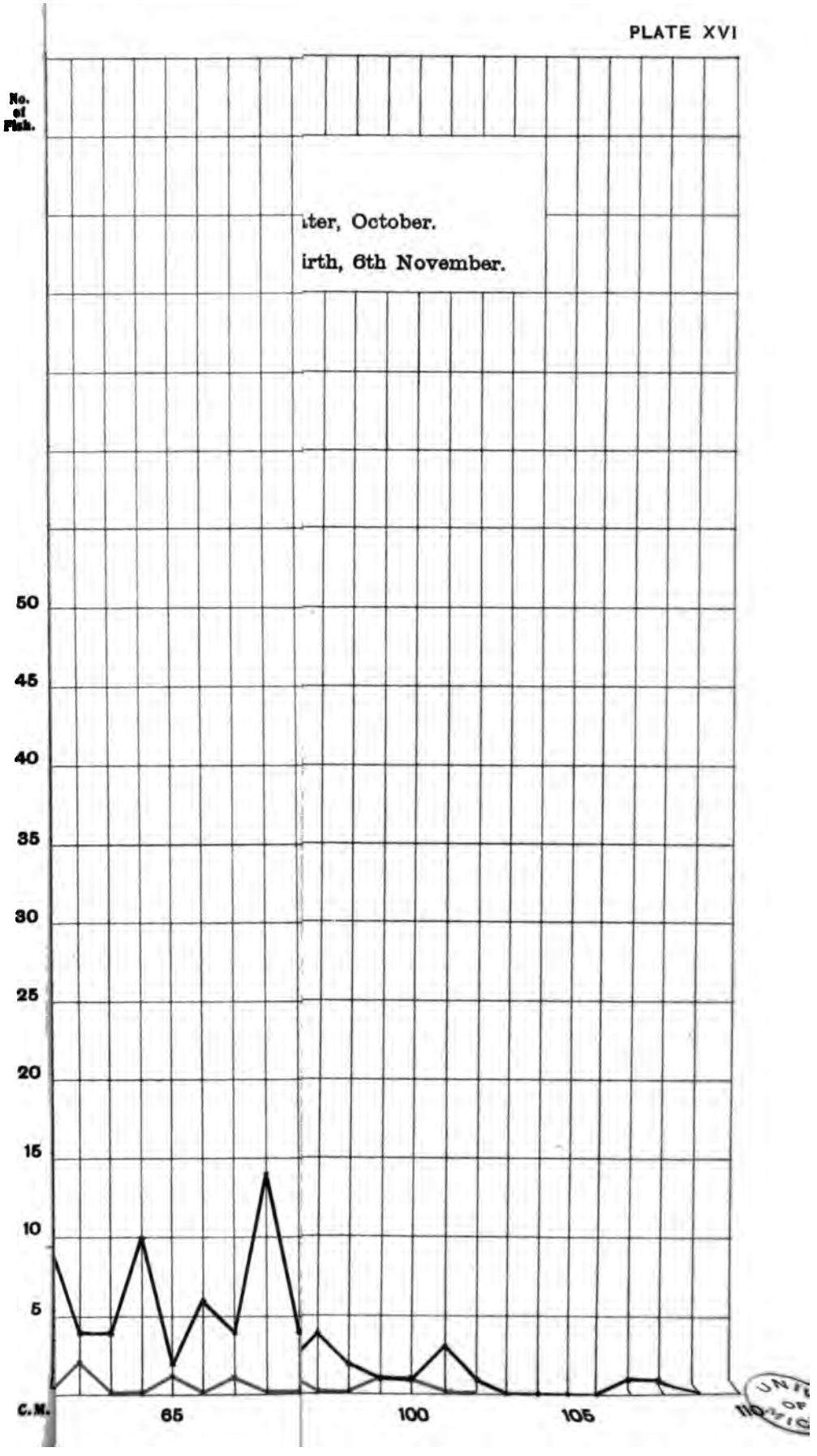

HADDOCK.—Aberdeen Bay.
8th and 13th October (1089 fish.)
31st October and 1st November (1767 fish).
17th and 19th December (735 fish).
55
56
57
58
59
60
61
62
63
64
65

PLATE XIV


No. of Fish.
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
8
6
4
2
0
33
34
35
36
37
38
39
40
41
42
43
44
45




No. of Fish.
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
8
6
4
2
37
38
39
40
61
62
63
64
65
66
67
68
69
70
eep Water.
r (small mesh).
r ,,
of the two above hauls.
of 18th October.


No. of Fish.
ıter, October.
irth, 6th November.
50
45
40
35
30
25
20
15
10
5
C.M.
65
100
105
110

VI.—REPORT ON THE HATCHING WORK AT THE MARINE HATCHERY, BAY OF NIGG, ABERDEEN, DURING THE SPRING SEASON 1900. By HARALD C. DANNEVIG.

In last year's Report it was stated that the hatching-house, pumps, and apparatus had been transferred to the site of the Marine Laboratory at Bay of Nigg, Aberdeen, and that the large concrete tank in which the spawning fishes are retained had been completed and worked satisfactorily. It was found, however, later that the large inflow pipe was leaking, so that fresh water present in the ground obtained admission, and at times somewhat reduced the specific gravity of the sea water in the pond, a defect which has now been remedied.

In preparation for the season's work a supply of adult plaice were obtained and were placed in the large tidal pond. While at Dunbar the supply of spawners was obtained from Granton and Newhaven trawlers, which were working mostly at a distance of twenty or thirty miles off the mouth of the Firth of Forth. A man was placed on board each of two or three boats, which almost daily came up to the Isle of May to discharge their catches into the carrier boats for the market, and the live plaice, which were kept in tubs and given a regular supply of water, were at the same time transferred to the "Garland" and taken to Dunbar. In order to secure a supply of spawners for this first season at the Bay of Nigg hatchery an ordinary trawler was authorised to work in the Moray Firth for a short time on condition that all the live plaice suitable for the hatchery were put aside for that purpose. The first voyage, which occupied the last week of December 1899, was unsuccessful, although a great number of fish was met with; exceptionally stormy weather which then prevailed made it impossible to keep the fish alive. The arrangements for the keeping of the live fish on board the trawler were improved, and the following trips, in January and early in February 1900, were attended with success. Each voyage generally lasted one week, and upon arriving in Aberdeen the fishes were at once conveyed to the tidal pond at the hatchery, where by February 3rd a total of 1419 plaice had been collected, the proportion between females and males being about three to one. The fish were nearly all caught on the Caithness coast, off Lybster and Dunbeath, at a distance from the shore of from two to three miles. The fishing on Smith's Bank as well as along the southern coast of the Firth was not attended with much success. The plaice for the Dunbar station were generally landed within twenty-four hours after their capture, and as owing to the frequent landings the numbers dealt with at a time were comparatively small, undue crowding in the tubs was avoided. While working this year in the Moray Firth the conditions in this

respect were different. The collection of the fishes was a gradual process lasting for one week or more, and the specimens that were first caught were confined in the tubs for all that time, while at the end of the voyage the total number of fish in hand was so great that crowding to a considerable extent was unavoidable. A regular and abundant supply of water was always provided day and night, yet it was easy to see that such specimens as had been long in the tubs were sluggish and weak, and owing to the constant friction the scales had often been removed from parts of the body. The latter feature, though unimportant in appearance at the time, is afterwards found to be a frequent cause of death. When these various circumstances were taken into consideration it was natural that a number of the newly captured fish should die soon; and almost daily dead plaice were removed from the pond. During the middle of February an exceptionally heavy south-easterly gale prevailed, which caused much loss of life and of vessels, while a great amount of damage was done to property ashore by flooding, etc. The breakwater in front of the pond had not by that time been completed, but in view of the bad weather its effectiveness had been temporarily augmented by means of heavy wooden beams, and large boxes filled with stones had been placed at the most exposed parts. But during the night of the 15th, when the gale was at its highest, several seas swept over the embankment and carried a quantity of gravel and soil with them into the pond. Owing to the continuance of the gale, which was attended with a heavy fall of snow, the pond could not be emptied until February 21st. On that day all the fishes were removed to the reservoir tank, where a constant and abundant circulation was maintained by means of the pumps. The water was obtained from the sea for the greater part of the thirty hours during which the fish were confined there, but while the tide was out it was necessary to repump the same water which was flowing away, care being taken to have a quantity of air mixed with the water before it was returned to the tank. After being thoroughly cleaned the pond was again refilled on the tide, and all the surviving plaice, 951 in number, were returned to it in a healthy condition.

During the early part of the season lug-worms were supplied as food for the plaice, but owing to the difficulty in obtaining this rather expensive article in the winter time mussels were resorted to and have been found satisfactory.

The hatchery was started on March 10th, when the first eggs were collected. This process was at Dunbar effected by means of a constant overflow which was maintained by the pumps, and carried the eggs from the spawning pond into a special apparatus—the egg-collector. But owing to the position and construction of the pond at Bay of Nigg, the same method would be less satisfactory. It is not, however, attended with much loss of time or other difficulties to "drag" or tow-net the pond with a large muslin net, suspended on a frame measuring 10 × 4 feet, and in this way the eggs do not suffer to the same extent from a prolonged crowding which would take place in an ordinary collector when left at work over night. About one week after the hatchery had been started very cold weather set in and caused a considerable reduction in the temperature of the sea water on the beach as well as in the pond. In the latter the temperature was twice down to the freezing point, and on one occasion it was even reduced to 1·6° C. below that point; ice at the same time covered the greater part of the surface. Artificial heating was resorted to, and by applying the exhaust steam from the pumps to a 2½-inch pipe which had been covered with wood and through which the pond water was circulated it

was possible to increase the temperature of the whole body of water in the pond by two and a half degrees. The fishes were sluggish at the time but did not otherwise appear affected by the low temperature, which, however, had a retarding influence upon the production of the eggs.

The daily progress of the hatching operations will be seen from Table I., which also contains records of the temperature and the specific gravity of the water in the hatchery, the pond, and the sea (taken at the surface on the beach). As will be seen, a total number of 43,290,000 eggs were collected from the pond from March 10th to May 5th, and of these 72·3 per cent., or 31,305,000, were successfully hatched. The death-rate amongst the eggs during incubation was much higher than usual, and was most distinctly due to the low specific gravity of the water that was obtainable for the hatchery, while the sea water on the beach is usually of quite a normal high specific gravity. As stated above, a leakage was found to have developed on the main supply pipe to the filter-chamber, so that a varying quantity of fresh ground-water was usually added to the supply for the pumps and accounted for the reduced salinity. The leakage took place in the ground outside the pond wall, and the amount of admixture of fresh water varied considerably according to the state of the tide. At or near high water the level of the sea was above that of the fresh water in the ground, and the sea water actually flowed through the defective parts of the pipe and a good salinity was obtainable for two or three hours. But during the flowing and ebbing tide, while the level of the sea was below that of the fresh water surrounding the pipe, the objectionable leakage took place. At half tide the water in the filter-chamber was seldom above 1024, while it often was considerably less. The defects in the supply pipe were repaired in the summer, and the salinity of the water for the pumps has since been much improved at all stages of the tide. There appears, however, to be reason to fear that the clay pipes, which are jointed with cement, may not be found strong enough to withstand for a long period of years the pressure to which they are sometimes exposed in stormy weather.

The fry from the hatchery was again taken to the upper parts of Loch Fyne and distributed at various places and under conditions as detailed in Table II. As it was possible to make the journey from Aberdeen to Inveraray during the night, when the air was sufficiently cold to render ice-packing unnecessary, the fry were transported in large carboy jars.

In the *Fishery Board's Sixteenth Annual Report*, Part iii., I described a successful experiment with rearing of plaice larvæ through the transformation stage, after which the young fish adopts the habits of the adult. During the season here dealt with some fry of plaice were again reared with success, and a few specimens that were kept over are still alive, and in January 1901 had an average size of about 3¼ inches.

TABLE I.—Showing the Daily Progress of the Hatching Operations, and the Temperature and the Specific Gravity of the Water in the Hatchery, in the Pond, and on the Beach

Date.	Number of Eggs collected.	Number of Eggs found dead in Boxes.	Number of Fry put out.	Total Stock in Boxes.	The Water in the Hatchery at noon.		The Water in the Pond at noon.		The Water on the Beach at noon.	
					Sp. gr.	Temp.	Sp. gr.	Temp.	Sp. gr.	Temp.
						Cent.		Cent.		Cent.
Mar. 10	1,560,000	...	...	1,560,000	26·0	5·0	26·0	5·0	27·3	4·6
,, 11	...	...	...	1,560,000	26·0	4·7	26·0	4·7	27·2	4·7
,, 12	5,590,000	...	...	7,150,000	26·1	4·6	26·1	4·8	27·1	4·6
,, 13	...	...	...	7,150,000	26·1	4·6	26·1	4·6	26·9	4·6
,, 14	3,900,000	...	...	11,050,000	26·1	4·5	26·1	4·8	27·0	4·4
,, 15	...	...	...	11,050,000	26·1	4·6	26·1	4·9	26·8	4·4
,, 16	...	1,200,000	...	9,850,000	26·0	4·0	26·0	4·7	27·0	4·2
,, 17	1,820,000	...	...	11,670,000	26·2	3·5	26·2	3·4	27·3	3·0
,, 18	...	...	...	11,670,000	26·3	−1·0	26·3	1·0	27·2	3·2
,, 19	...	...	...	11,670,000	26·3	...	26·3	*1·0	27·0	3·6
,, 20	...	...	...	11,670,000	26·2	1·7	26·2	2·5	27·0	4·1
,, 21	1,690,000	...	...	13,360,000	26·1	3·5	26·1	3·8	26·8	4·4
,, 22	...	...	...	13,360,000	26·0	4·0	26·0	4·0	26·3	4·6
,, 23	3,120,000	...	...	16,480,000	26·0	4·1	26·0	4·4	26·3	5·3
,, 24	...	1,150,000	...	15,330,000	26·0	4·2	26·0	4·4	26·3	5·4
,, 25	1,950,000	...	...	17,280,000	26·2	4·1	26·0	4·2	26·9	5·1
,, 26	1,690,000	...	...	18,970,000	26·3	4·2	26·0	4·4	27·3	4·5
,, 27	1,560,000	...	...	20,530,000	26·4	4·5	26·1	4·3	27·6	4·3
,, 28	...	...	...	20,530,000	26·5	4·8	26·1	4·4	27·6	4·3
,, 29	910,000	850,000	...	20,590,000	26·3	4·0	26·0	4·4	27·5	4·4
,, 30	1,625,000	450,000	...	21,765,000	26·4	5·3	26·4	5·0	27·4	4·9
,, 31	624,000	...	...	22,389,000	26·8	5·6	26·4	5·1	27·5	4·4
Ap. 1	...	1,300,000	...	21,089,000	26·9	5·8	26·7	5·6	27·6	4·4
,, 2	2,210,000	...	...	23,299,000	26·9	6·1	26·7	5·5	27·6	4·5
,, 3	1,560,000	...	...	24,859,000	27·0	5·8	26·9	5·3	27·5	4·5
,, 4	1,105,000	...	...	25 964,000	27·0	5·9	26·9	5·2	27·7	4·5
,, 5	...	...	...	25,964,000	27·0	6·2	26·9	5·3	27·6	4·6
,, 6	2,860,000	2,450,000	455,000	25,919,000	26·9	6·4	26·6	6·8	27·6	4·7
,, 7	936,000	...	...	26,855 000	26·5	6·7	26·6	7·4	27·2	4·8
,, 8	...	...	...	26,855,000	...	...	...	...	...	...
,, 9	...	...	...	26,855,000	...	...	...	...	...	...
,, 10	...	...	2,730,000	24,125,000	26·8	6·7	26·5	7·4	27·2	4·9
,, 11	4,160 000	...	...	28,285,000	26·5	6·8	26·6	8·0	27·3	4·9

*In the early morning the temperature of the pond was −1·6°C. while there was ice on the surface.

TABLE I.—*continued.*

Date.	Number of Eggs collected.	Number of Eggs found dead in Boxes.	Number of Fry put out.	Total Stock in Boxes.	The Water in the Hatchery at noon.		The Water in the Pond at noon.		The Water on the Beach at noon.	
					Sp. gr.	Temp.	Sp. gr.	Temp.	Sp. gr.	Temp.
						Cent.		Cent.		Cent.
Ap. 12	...	1,100,000	...	27,185,000	26·9	6·1	26·6	7·9	27·3	4·8
,, 13	910,000	...	...	28,095,000	27·0	6·8	26·6	7·8	27·4	5·0
,, 14	715,000	750,000	...	28,060,000	27·0	6·8	26·7	7·2	27·4	5·2
,, 15	...	375,000	...	27,685,000	...	...	...	...	...	...
,, 16	...	...	...	27,685,000	27·	7·3	26·6	7·1	27·4	5·8
,, 17	...	...	3,380,000	24,305,000	27·2	8·8	26·6	6·8	27·4	6·3
,, 18	...	...	...	24,305,000	...	...	...	...	...	...
,, 19	650,000	...	...	24,955,000	27·0	9·0	26·7	9·0	26·7	8·4
,, 20	...	...	...	24,955,000	27·1	10·1	26·7	9·3	...	...
,, 21	...	1,180,000	...	23,775,000	26·9	10·3	26·6	9·8	26·8	8·6
,, 22	...	...	...	23,775,000	...	...	...	...	...	...
,, 23	1,690,000	...	...	25,465,000	26·9	8·7	26·6	10·6	27·2	8·6
,, 24	...	480,000	4,290,000	20,695,000	26·7	9·1	26·6	8·0	27·3	8·6
,, 25	...	...	...	20,695,000	26·8	9·6	26·6	8·0	27·3	8·6
,, 26	...	...	260,000	20,435,000	26·6	10·1	26·6	8·0	27·3	8·5
,, 27	...	...	...	20,435,000	26·8	9·7	26·6	8·2	27·3	8·4
,, 28	250,000	510,000	4,160,000	16,015,000	27·0	9·4	26·6	8·3	27·4	8·5
,, 29	...	...	...	16,015,000	27·0	9·6	26·7	8·7	27·3	8·5
,, 30	160,000	...	...	16,175,000	27·2	9·1	...	...	...	...
May 1	...	...	...	16,175,000	27·3	8·7	26·7	8·6	27·3	8·5
,, 2	...	160,000	5,460,000	10,555,000	27·2	8·5	26·8	8·6	27·3	8·5
,, 3	...	...	...	10,555,000	27·1	8·5	26·8	8·6	27·3	8·5
,, 4	...	...	...	10,555,000	27·2	8·5	26·8	8·6	27·3	8·5
,, 5	45,000	...	5,600,000	5,000,000	27·1	8·5	26·8	8·7	27·3	8·5
,, 6	...	...	...	5,000,000	27·0	8·5	26·8	8·7	27·3	8·5
,, 7	...	...	...	5,000,000	26·9	8·5	26·7	9·0	27·2	8·5
,, 8	...	...	...	5,000,000	26·6	8·5	26·7	9·0	27·2	8·5
,, 9	...	30,000	3,100,000	1,870,000	26·9	8·5	26·7	9·0	27·2	8·5
,, 10	...	...	...	1,870,000	26·7	8·5	26·7	9·0	27·2	8·5
,, 11	...	...	...	1,870,000	26·8	8·5	26·6	9·0	27·2	8·5
,, 12	...	...	1,870,000	...	...	...	...	...	...	...
	43,290,000		31,305,000							

TABLE II.—Showing the Distribution of the Fry, and the Physical Conditions under which they were Planted.

Date.	Hour.	Locality.	Surface.		12 ft. down.	Wind.	Tide.	Number of Fry Planted.
			Sp. gravity.	Temp. in Cent.	Sp. gravity and Temp.			
April 6th	10 a.m.	Bay of Nigg, Aberdeen.	...	...	...	...	4½ h. ebb.	455,000
,, 10th	7 a.m.	Loch Fyne: Off Strone Point.	1025·3	...	...	W.N.W., light.	4 h. flood.	2,730,000
,, 17th	7 a.m.	Loch Fyne: Off St. Catherine's to off Dunderave Castle.	1021·0	7·7	...	S.W., light.	5 h. ebb.	3,380,000
,, 24th	7 a.m.	Loch Fyne: Off Inveraray.	1021·3	8·9	$\left\{\frac{1023·1}{8·1°}\right\}$	E.N.E., strong.	H.-W.	4,290,000
,, 26th	4 p.m.	Bay of Nigg, Aberdeen.	...	...	...	...	5 h. ebb.	260,000
,, 28th	6.45 a.m.	Loch Fyne: A line 1 mile long half way between Inveraray and St. Catherine's.	1025·9	8·0	...	Calm.	1½ h. flood.	4,160,000
May 2nd	8 a.m.	Loch Fyne: In the middle of the loch, off Poll Point.	1025·3	8·3	...	S.W., gale.	L.-W.	5,460,000
,, 5th	7.30 a.m.	Loch Fyne: Off Poll Point.	1018·0	8·1	$\left\{\frac{1023·7}{8·4°}\right\}$	Calm.	3½ h. ebb.	5,600,000
,, 9th	7 a.m.	Loch Fyne: Off Strone Point.	1024·7	8·3	$\left\{\frac{1025·6}{8·4°}\right\}$	N.E., moderate.	4½ h. flood.	3,100,000
,, 12th	7 a.m.	Loch Fyne: Between Strone Point and St. Catherine's.	1026·2	7·8	...	E., light.	2½ h. flood.	1,870,000

NOTES ON GATHERINGS OF CRUSTACEA, COLLECTED FOR THE MOST PART BY THE FISHERY STEAMER "GARLAND" AND THE STEAM TRAWLER "ST. ANDREW" OF ABERDEEN, AND EXAMINED DURING THE YEAR 1900.

By Thomas Scott, F.L.S., Mem. Soc. Zool. de France.

(Plates XVII. and XVIII.)

Contents.

	PAGE
Introductory Remarks, ...	235
Copepoda, ...	237
Ostracoda, ...	256
Amphipoda, ...	258
Isopoda, ...	268
Sympoda (Cumacea), ...	273
Schizopoda, ...	276
Macrura, ...	278
Brachyura, ...	279
Explanation of the Plates, ...	280, 281

INTRODUCTORY REMARKS.

These Notes form a continuation of the series of papers which have from time to time been published in Part III. of the Annual Reports of the Fishery Board for Scotland. The purpose of these notes is to record, in a more or less accessible form, some, at least, of the interesting organisms that have been, and still are being, obtained in connection with the investigations carried on under the authority of the Fishery Board.

It is now generally acknowledged that the Crustacea constitute a considerable portion of the food of our food-fishes, and, as will be shown in the sequel, several of the Crustaceans to be recorded here have only so far been obtained in the stomachs of fishes; a knowledge, therefore, of the kinds and distribution of these organisms is necessarily of more than merely zoological importance.

During the past year a considerable amount of information concerning the distribution of the Crustacea has been obtained, and a number of species have been added to the marine fauna not only of Scotland but also of the British Islands, while a few are apparently new to science. A considerable number of rare species have been obtained in gatherings collected by the "Garland" and forwarded to the Laboratory at Bay of Nigg. Several rich gatherings of Crustacea were also collected by the steam trawler "St. Andrew" of Aberdeen, which carried on some experiments to the east of the Orkney and Shetland Islands during the months of September and October last. One or two of the richest gatherings

examined during the past year were collected by the "St. Andrew" off the Fair Island in October. The following are a few of the Crustacean species observed in the "St. Andrew" gatherings :—

Eucalanus elongatus (Dana).
Eucalanus crassus, Giesbrecht.
Rhincalanus (?) *gigas*, Brady.
**Cyclopina longifurcata*, sp. n.
**Eucanuella spinifera*, gen. et sp. n.
Macrocypris minna (Baird).
Euonyx chelatus, Norman.
Byblis gaimardi (Kröyer).
Aceros phyllonyx (M. Sars).
Læmatophilus tuberculatus, Bruzel.
Dulichia monacantha, Metz.
Arcturella delatata, G. O. Sars.
Paramunna bilobata, G. O. Sars.
Macrostylis spinifera, G. O. Sars.
Echinopleura aculeata, G. O. Sars.
Diastylis cornuta (Boeck).
Diastylopsis resima (Kröyer).
Leptostylis villosa, G. O. Sars.
Pseudocuma similis, G. O. Sars.
Campylaspis rubicunda (Lillj.).
Campylaspis costata, G. O. Sars.
Erythrops serrata, G. O. Sars.

Several organisms other than Crustacea were also observed in the gatherings collected by the "St. Andrew," the following of which may be mentioned :—

Clio pyramidata, Browne, obtained fifty miles S.E. of Fair Island (living when captured), October 19th, 1900.
Natica grœnlandica, Beck, dead, but fresh shell.
Siphonodentalium lofotense, Sars, a few specimens; and the following Foraminifera :—*Saccamina sphæra*, *Psammosphæra fusca*, *Astrorhiza arenaria*, *Placopsilina bulla*.

Some interesting collections were also sent from the "Garland," and especially those from the deep water off Aberdeen. Some moderately rare species belonging to the Amphipoda, Isopoda, Sympoda, and Macrura were obtained off Aberdeen, comprising such forms as the beautiful *Epimeria cornigera*, the curious *Lepidepecrium longicorne*, and *Euonyx chelatus*, and also the following rare forms :—*Amphilochoides intermedius*, T. Scott, *Metopina robusta* (G. O. Sars), *Cuma pulchella*, G. O. Sars, *Petalosarsia declivis*, G. O. Sars, *Pleurogonium inerme*, G. O. Sars, and a number of other minute species.

Copepoda were not very plentiful, neither in these gatherings nor in those collected by the "St. Andrew," but nevertheless interesting species will be found recorded in the sequel. A curious and somewhat abnormal form which was dredged by the "Garland" at Tarbert Bank, Loch Fyne, I have been unable to identify with any known species or genus, and have therefore recorded it under the name of *Cancerina confusa*; it resembles in some measure the *Cancerilla tubulosa* discovered by Sir John Graham Dalyell as the parasite of a Starfish, but it differs from that Copepod in several important points.

In concluding these introductory remarks, I desire to acknowledge my indebtedness to Mr. F. G. Pearcey of the "Garland" and to Mr. Dannevig for the valuable gatherings of Crustacea which they have collected, and which have yielded so many interesting species. I have also to thank Mr. H. C. Williamson for a few rare forms, and especially for *Ischyrocerus anguipes*, Kröyer, which he discovered in the Bay of Nigg, and of which there is no previous authentic British record.

My son, Mr. Andrew Scott, assisted by Mrs. Scott, has prepared the drawings necessary to illustrate several of the species described in the sequel.

*These were obtained in the stomach of a small Haddock captured about sixty-five miles south-east by east of Sumburgh Head, Shetland, on September 4th, 1900.

CRUSTACEA.

SUB-CLASS ENTOMOSTRACA.

Order I. COPEPODA.

CALANIDÆ.

Eucalanus elongatus (Dana); and *Eucalanus crassus*, Giesbrecht.

I have at different times during the past few years recorded these two species of *Eucalanus* from the north-east and north of Scotland, and this year I have again to note their occurrence in Scottish waters, but from a locality different from those previously mentioned—viz., at about fifty miles south-east of the Fair Island, between Orkney and Shetland. They were obtained in at least two tow-net gatherings collected on October 19th, 1900, by the steam trawler "St. Andrew." A number of specimens of both species were observed in this gathering.

Rhincalanus (?) *gigas*, Brady. (Pl. XVII., figs. 1–4.)

Rhincalanus gigas, Brady, Challenger Reports, vol. viii., Copepoda, p. 42, Pl. VIII., figs 1–11.

Several specimens of a *Rhincalanus*, apparently belonging to *R. gigas*, Brady, were obtained in one of the tow-net gatherings collected to the eastward of the Fair Island, in which the two species of *Eucalanus* mentioned above were observed. Most of the specimens were females, and were apparently adult; about half a dozen males were also observed, but they were considerably smaller than the females, and appeared to be scarcely mature.

The only apparent difference between these female specimens and *R. gigas*, Brady, is in their size. The specimens of *Rhincalanus gigas* described by Dr. Brady measured from 8·5 to 10 millimeters, while those collected to the eastward of the Fair Island were 5 mm. in length. In these specimens the fifth pair of feet in the female are identical in form and armature with those of *R. gigas*. Figures 10 and 11 of Plate VIII. in Dr. Brady's "Challenger" Report probably represent the fifth feet and abdomen of a male specimen; they resemble closely figures 2 and 4 on Plate XVII. of this paper, which represent similar parts of one of the immature males in the collections from the Fair Island. Figure 3 (Plate XVII.) represents the last thoracic segment and abdomen of one of the female specimens. I am inclined to ascribe the Fair Island specimens to *R. gigas*, though they are somewhat smaller than those recorded by Dr. Brady, rather than to *R. nasutus*, Giesbrecht. It may also be noted in passing that *R. nasutus* is in some respects, and especially in the form of the female fifth feet, not very unlike *R. gigas*, Brady.

Stephus gyrans (Giesbrecht).

1892. *Möbianus gyrans*, Giesbrecht, Pelagischen Copep. d. Golfes v. Neapel, p. 205, Pl. 5, 9, 35.
1897. *Stephus gyrans*, T Scott, Fifteenth Ann. Rept., Part III., p. 146, Pl. II., fig. 9; Pl. III, figs. 17, 18.

This distinct species was recorded for Loch Fyne in 1897, and up till last year this was the only Scottish locality where *Stephus gyrans* had been observed; now, however, I am enabled to record it from a second

locality, also in the West of Scotland, viz., in the Sound of Mull, where it was collected by the "Garland" in 72 fathoms on March 31st, 1900. This record shows that, though the species may be rare, its distribution in Scottish waters is probably fairly extensive.

Ætidius armatus, G. S. Brady.

A few specimens of this curious species were obtained in tow-net gatherings collected to the eastward of the Fair Island in October, 1900, but they were all females, and in connection with this it is interesting to note that the specimens in the collections made by H.M.S. "Research" in the Shetland-Faröe Channel in July and August, 1896, were also all females.* In *Ætidius armatus* the bifid rostrum with its stout spine-like branches, which projects from the front of the head at nearly right angles to the body, appears, when seen in profile, not unlike the beak of a bird. It was this character of the rostrum which suggested to Dr. Brady the name of the genus.†

Bradyidius armatus, Vanhöffen.

This species was collected with the tow-net in October, 1900, off the Fair Island.

Scolecithrix hibernica, A. Scott.

This species, which was discovered in the Irish Sea by my son, and which has been observed in the Firth of Clyde and the Moray Firth by myself, has now to be recorded from a new station—viz., about fifty miles south-south-east of the Fair Island, between Orkney and Shetland. It occurred in a gathering collected with a tow-net fixed to the head of one of the trawls of the steam trawler "St. Andrew," on October 16th, 1900, while that vessel was engaged in carrying on the investigations referred to in the preliminary remarks. This is the farthest north of any of the localities where *S. hibernica* has yet been observed.

CENTROPAGIDÆ.

Centropages typicus, Kröyer.

Specimens of this species were obtained in Lerwick Bay, Shetland, by the steam trawler "St. Andrew" while at anchor there in October last. It was also observed to be moderately frequent off the Fair Island on the 19th of the same month.

Centropages hamatus (Lilljeborg).

This *Centropages* occurred in a tow-net gathering collected in Lerwick Harbour about the same time as the specimens of *C. typicus* were collected.

Eurytemora affinis (Poppe).

This Copepod occurred in great abundance in some of the hatching boxes at the Sea-Fish Hatchery at Bay of Nigg, at the end of the hatching season last year (1900).

* Notes on the Animal Plankton from H.M.S. "Research." *Fifteenth Annual Report of the Fishery Board for Scotland*, Part III., p. 313 (1897).

† Report on the Copepoda collected by H.M.S. "Challenger," p. 75.

Metridia lucens, Boeck.

This species was taken with the surface tow-net in Lerwick Bay on October 15th, 1900. It was also obtained in a tow-net gathering collected about fifty miles south-east of the Fair Island on the 19th of the same month. *M. lucens* is not only smaller than *Metridia longa* (Lubbock), but the structure of the fifth feet is different.

Paramisophria cluthæ, T. Scott.

P. cluthæ, which was described in Part III. of the Fifteenth Annual Report of the Fishery Board for Scotland, has only hitherto been recorded for Loch Fyne, Firth of Clyde; I have now to record the species from the Cromarty Firth. It occurred in some material collected there on January 17th, 1900, and forwarded from the Fishery steamer "Garland" to the Laboratory at Bay of Nigg.

CANDACIIDÆ.

Candacia pectinata, G. S. Brady.

This species was observed during the past year not only in tow-net gatherings from the Clyde and the Moray Firth, but also in one or two gatherings collected in October to the eastward of the Fair Island, between Orkney and Shetland, and also in Lerwick Bay. The distribution of *C. pectinata* would thus seem to be co-extensive with the British Islands.

PONTELLIDÆ.

Anomalocera patersonii, Templeton.

A number of specimens of this fine species occurred in one of the tow-net gatherings collected to the eastward of the Fair Island on October 19th. These specimens appeared to be even more highly coloured than those observed in the Clyde and the Moray Firth.

Acartia discaudata, Giesbrecht.

The only Scottish locality where, till recently, I have observed *Acartia discaudata* is the Firth of Forth, but I have now to record it from other two stations, from both of which specimens have been sent to the Laboratory at Bay of Nigg from the "Garland." At one of these stations—viz., Loch Eil, at the head of Loch Linnhe—specimens of *A. discaudata* were dredged in 10 to 30 fathoms on March 4th, 1900; while at the other—viz., Dornoch Firth, near Muckle Ferry—the species was moderately common in gatherings collected with the surface tow-net between the 16th and 17th of May.

Acartia bifilosa, Giesbrecht.

A second species of *Acartia—A. bifilosa*—was obtained in a tow-net gathering collected in Lerwick Harbour on October 15th, 1900, by the steam trawler "St. Andrew." It may be mentioned that another species of *Acartia—A. clausii*, Giesbrecht—was obtained during the investigations in which the "St. Andrew" was engaged. It was collected about seven miles off shore between Lerwick and Sumburgh Head on October the 16th, by passing the water from the donkey-pump through a tow-net. *Acartia clausii* occurred also in tow-net gatherings collected to the eastward of the Fair Island on the 19th of the same month.

Cyclopidæ.

Pterinopsyllus insignis, G. S. Brady.

A few specimens of this somewhat rare species were obtained in some material collected in the Moray Firth about thirteen or fourteen miles north-east of Buckie, in about 50 to 55 fathoms, on November 3rd, 1900; one or two of them were females, and carried small roundish ovi-sacs,—these are the first specimens of *Pterinopsyllus* which I have seen carrying eggs.

Cyclopina gracilis, Claus.

Specimens of this small but distinct species were obtained in the store pond of the Sea-Fish Hatchery at Bay of Nigg on October 1st, 1900.

Cyclopina longifurcata, T. Scott (sp. n.). (Pl. XVII., figs. 5–14.)

Description of the female.—In this species the body is moderately stout, the forehead is narrowly but evenly rounded, and the abdomen is slender and elongated; the caudal furca are very long and somewhat lamelliform, being rather more than half the length of the abdomen; the entire length of the animal from the forehead to the end of the furca is about 1·56 mm. (about $\frac{1}{16}$ of an inch); (fig. 5).

The antennules (fig. 6) are slender and about as long as the cephalic segment; they appear to be composed of twenty-six joints, and are sparingly setiferous; all the joints are short, but the ultimate and penultimate joints are rather longer than the others; the formula shows the number and approximate proportional lengths of all the joints:—

Number of the joints,	1	2	3	4	5	6	7	8	9	10	11	12	
Proportional lengths of the joints,	11	4	4	3	3	3	4	5	6	4	5	4	
No. of joints,	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Pro. len. of jts.,	5	5	7	9	9	8	9	10	8	7	8	6	12	13

The antennæ are four-jointed, the joints are sub-equal and of moderate length, the third and fourth joints carry one or two long, slender, plain setæ at their distal extremities, the first joint is furnished with a few plumose hairs, three of which spring from a small tubercle situated near the distal end of the outer margin, as shown in the figure (fig. 7). This tubercle, with its fascicle of three plumose setæ, is probably a rudimentary secondary branch.

The mandibles are moderately stout, and provided with well-developed two-branched palps, the branches of which arise from a moderately stout basal joint, the upper branch is two- but the lower is four-jointed, both branches carry several long plumose setæ (fig. 8). The mandibles of this species have a general resemblance to those of *Cyclopina littoralis*, G. S. Brady.

The maxillæ, which are small, possess a distinctly two-branched palp, both branches of which are furnished with long plumose setæ, the manducatory lobe bears on its inner distal aspect one or two moderately stout and several small setæ, all of which are plumose (fig. 9).

The first maxillipedes resemble those of *Cyclopina littoralis*, they are moderately stout, apparently six-jointed, but though the basal joints are dilated, the end ones are small; the marginal lobe-like processes of the second and third joints are each armed with a moderately stout and long claw-like spine and a few setæ, while a number of stout plain setæ spring from the margins and apex of the three end-joints (fig. 10).

The second maxillipedes are also somewhat similar to those of *Cyclopina littoralis*. The first and second joints are elongated and moderately stout;

in the first the inner margin is slightly lobate towards the distal end, and one or two moderately stout setæ spring from the rounded apex of each lobe; the gently rounded inner margin of the second joint is fringed with minute hairs, and carries one or two setæ near its distal end; the remaining five joints are small, the end one is provided with two short and two long terminal setæ, a long seta also springs from the inner aspect of the penultimate joint, while the three preceding joints are furnished with a few setæ as shown by the drawing (fig 11).

The first four pair of swimming feet are, each of them, two-branched and both branches are three-jointed. The outer branches of the first pair have their exterior margins armed with elongated spines arranged as follows:—One near the distal end of the first joint, one on the second joint, three on the margin and one (larger than the others) at the end of the third joint; a single long plumose seta springs also from the inner margins of the first and second joints, and four from the inner edge of the third joint. The first and second joints of the inner branches have no setæ or spines on the outer margin, but the first joint bears one and the second two setæ on the inner edge, while the third joint bears one seta near the middle of the outer margin, three on the inner margin, and two at the apex. The armature of the other three pairs of swimming feet is somewhat similar to that of the first, except that the third joint of the outer branches of the fourth pair carries five setæ on the inner margin; moreover, in the fourth pair the third joint in both branches is proportionally rather more elongated, being about equal to the entire length of the first and second joints combined (figs. 12, 13). The spines on the outer margins of the outer branches in all the four pairs are of a sabre-like form, with the edges minutely serrated.

The fifth pair of thoracic feet are each composed of a single two-jointed branch, the first joint is somewhat dilated, being about as broad as long, but the second is narrow and moderately elongated, and furnished with five setæ, one being situated near the middle of the outer margin, and four around the distal end (fig. 14).

Habitat.—In the stomach of a small Haddock, *Gadus æglefinus*, L., 88mm. (about 3½ inches) in length, captured 65 miles east by south of Sumburgh Head, Shetland, September 4th, 1900, by the steam trawler "St. Andrew."

Remarks.—The species now described agrees in some of its more important characters with the genus *Cyclopina* of Claus; but in that genus the antennules are described as being shorter than the cephalic segment, while the number of joints in those of the species hitherto recorded is not more than twenty-two or twenty-three; in *C. longifurcata*, on the other hand, the antennules are not only as long as the cephalic segment, but they are also apparently twenty-six-jointed; then again the antennæ of *Cyclopina* are described as four-jointed, but the third joint is very short, whereas in our specimen the third is as long as the fourth joint. Notwithstanding these and one or two other minor differences, the specimen seems to be a true *Cyclopina*. Only the one specimen was observed; and as it was apparently quite uninjured, it had probably only been a short time in the Haddock's stomach before the Haddock itself was captured.

Ascidicolidæ.

(?) *Enteropsis vararensis*, T. Scott (sp. n.). (Pl. XVII., figs. 28–34.)

Description of the female.—Length 1·2 mm. (about $\frac{1}{20}$ of an inch), Body robust, cylindrical, slightly recurved. The cephalon is very small.

and the cephalic appendages are therefore somewhat crowded together near the anterior end and on the ventral aspect of the body. The thorax exhibits a slightly articulated structure, but there is no apparent segmentation of the abdomen, this part of the body is not differentiated from the thorax; the caudal appendages are very small (fig. 28).

The antennules are very short and moderately stout; they taper towards the distal end, and are each composed of three joints of nearly equal length, and bear three short terminal spines, but are otherwise unprovided with spines or setæ (fig. 29).

The antennæ are simple, and are each composed of two dilated joints and armed with a strong terminal claw; there are no secondary branches (fig. 30).

The mandibles are of moderate length, and they each consist of a stout and slightly curved claw-like appendage; there does not appear to be a mandible-palp (fig. 31).

The maxillæ, which are of a simple structure, appear to be two-jointed, the basal joint is stout, but the end one consists of a somewhat narrow and elongated plate, rounded and slightly crenulate at the extremity (fig. 32).

Only one pair of maxillipedes could be made out, and these are very rudimentary; they each consist of a slightly elevated and broadly rounded prominence armed with a small apical spine (fig. 33).

The thoracic feet comprise four pairs, they are very small but comparatively stout, and appear to be all more or less uniform in structure. Each foot is composed of a single two-jointed branch, both joints are somewhat dilated, but the end one is much smaller than the other, and is armed with two short and apparently movable terminal spines (fig. 34). The position of the first pair is somewhat abnormal, they are not in line with the other three pairs, as is more or less usually the case with free-living species, but are situated round towards the lateral aspect; this position of the first pair does not appear to be accidental, but has been observed in the other specimens examined.

It will also be observed that the genital opening is situated on the dorsal aspect of the abdominal part of the body (see fig. 28).

Habitat.—In the branchial chambers of a compound Ascidian (*Botryllus* sp.), associated with *Botryllophilus* (?) *ruber*; not very common. The *Botryllus* was dredged in the Moray Firth in 1896.

Remarks.—This species, if not a true *Enteropsis*, is very closely allied to that genus. The most important point of difference seems to be the apparent absence of a mandible-palp. If the presence of this appendage is clearly established in the other members of the species *Enteropsis*, the one now described may have to be removed to some other genus or a new one instituted for its reception.

Botryllophilus (?) *ruber*, Hesse. (Pl. XVII., figs. 15–27.)

1864. *Botryllophilus ruber*, Hesse, Ann. Sci. Nat., Zool. (5), t. i., Pl. XII., figs. 1–7.

1900. *Botryllophilus* (?) *ruber*, T. Scott, 18th Ann. Rept. Fishery Board for Scot., Part III., p. 388.

In my paper "Notes on some gatherings of Crustacea," published in Paper III. of the Eighteenth Annual Report, I recorded the occurrence of a *Botryllophilus*, in the Clyde and the Moray Firth, under the name of *Botryllophilus* (?) *ruber*, Hesse, but only the females had at that time been observed. In consequence of further research I am able to give a more detailed description of the species than was done last year, and to include

in it an account of the male as well as of the female. In my previous record of the species I stated that one of the peculiarities of *Botryllophilus* was "the almost constant existence of a single ovigerous sac of a strictly spherical form sheltered between the fifth feet." I now find that this sac in the specimens observed, both in the Clyde and the Moray Firths, is really composed of two sacs, partly adherent to each other and so closely joined as to appear as if they formed but a single globular mass.

Description of the female.—Length of the specimen figured, 1·16 mm. (about $\frac{1}{16}$ of an inch). The cephalothorax, which terminates anteriorly in a short bluntly rounded rostrum, is somewhat narrow in front, but becomes gradually dilated towards the posterior end and especially on the dorsal aspect. Scarcely any trace of segmentation can be made out in the cephalothoracic region, but this is probably due to the fact that the *Botryllus* in which the specimen was obtained had been for several years (since 1896) preserved in alcohol. The abdomen is narrow and elongated, but is rather shorter than the cephalothorax (fig. 15).

The antennules are very short and composed of four joints, the first is considerably dilated, the second is moderately stout but much smaller than the first; the third and fourth are small; the antennules are furnished with a number of long and moderately stout setæ, which appear to be devoid of feathering (fig. 17).

The antennæ, which are two-jointed, are comparatively long and slender and of nearly equal thickness throughout, they are each composed of two (or (?) three) joints; the end joint is provided with three stout spines on its inner margin, and a few spines and setæ at the apex, the other joints appear to be unarmed (fig. 18). The antennæ are not provided with secondary branches.

The mandibles and maxillæ appear to be obsolete or very rudimentary.

The first maxillipedes are small and feeble, they are each composed of three joints, the second and third joints are sub-equal and rather smaller than the first; the first joint is unarmed, the second bears two or three spine-like setæ on its inner aspect, and the third is provided with a few terminal setæ of unequal lengths, the outermost being considerably longer than any of the others (fig. 19).

The second maxillipedes are short but somewhat robust, the basal joint is moderately distended, and larger than the second one, the third joint is very small, the end-joint is narrow and fully twice the length of the third and bears a short but strong terminal claw (fig. 20).

The thoracic feet.—All the thoracic feet, with the exception of the fifth pair, are short and robust and composed of two branches. In the first and second pairs, the inner branches are very short and two-jointed; about eight plumose setæ of moderate length spring from the rounded apex of the second joint, and one from the inner margin of the first joint. The outer branches, which appear to be uniarticulate, are rather longer than the inner ones and are armed with a few small marginal and apical spines, as shown in the drawing (fig. 21). In the third and fourth pairs the outer as well as the inner branches are two-jointed; the inner branches, which are somewhat alike in both pairs, are rather longer than those of the first pair, but their armature is somewhat similar, except that the end-joints bear six instead of eight plumose setæ; the outer branches of the third pair are somewhat similar to those of the first except that there is an articulation between the two proximal marginal spines, dividing the branches into two joints (fig. 22); the outer branches of the fourth pair are less robust than the inner branches, but are nearly equal to them in length; a single small seta springs from near the end of the outer margin of the first joint, while the second is furnished with four apical and sub-

apical setæ, the two outer sub-apical setæ are small, but the other two are moderately stout and unequal in length, the inner one being the longest, both are feathered on the distal half (fig. 23). Each foot of the fifth pair consists of a single uniarticulated branch, elongated and somewhat slender and spine-like; this pair, instead of being situated on the ventral aspect, which is the usual position in the majority of Copepods, are placed well round towards the back, and are probably utilised for supporting between them the egg-sacs which combine to form a globular mass on the dorsal aspect of the genital segment of the abdomen. This globular mass is easily detached, and would be even more so were it not supported and kept in position by the fifth feet (fig. 15).

The first segment of the abdomen is of moderate size, but the other segments are small; the caudal furca are very short and somewhat divaricate.

Description of the male.—The male is about half the size of the female, being only ·825 mm. (about the $\frac{1}{30}$ of an inch) in length. The cephalothorax is distinctly segmented, and of a somewhat oval outline, the cephalic segment is moderately large, being equal to about two-fifths the entire length of the cephalothorax, but the thoracic segments are small. The genital segment of the abdomen is somewhat dilated, and equal to about half the entire length of the remaining segments and the caudal furca combined, the posterior portion of the abdomen is composed of what appear to be seven or eight distinct articulations, but with the exception of the ultimate segment they are for the most part very small; the caudal furca, which are scarcely equal in length to the last abdominal segment, are each provided with a small seta near the base of the outer margin in addition to a few short apical setæ (fig. 16).

The antennules are very short and four-jointed, the first joint is moderately large and somewhat inflated, numerous delicate hairs spring from its rounded upper surface, as shown in the drawing (fig. 24). The remaining joints are small, the second one and the last are furnished with several delicate hairs similar to those on the first joint.

The thoracic feet.—The first four pairs of thoracic feet are all two-branched, and the outer branches are all three-jointed and armed on their exterior margins with strong sabre-like spines, the first and second joints being each furnished with one of these spines, and the third joints with three, except that the third joints of the first pair carry four spines; in all the outer branches the terminal spines are considerably larger than the others. Moreover, in the outer branches of all the four pairs, the inner margins of the first joints appear to be devoid of spines or setæ, but the second joints are each provided with one plumose seta on the inner margin; on the other hand, the third joints of the outer branches of the first pair have only four plumose setæ on their inner margin, while on the inner margin of the third joints of the next three pairs there are five plumose setæ, so that though the outer branches of the first pair have one spine more than the other three pairs, the number of setæ is correspondingly fewer.

But although all the four pairs of thoracic feet are somewhat similar as regards the structure and armature of the outer branches, a considerable divergence is observable when the inner branches are compared. In the first pair of feet the inner branches are composed of a single small but somewhat tumid joint bearing one or two claw-like spines (fig. 25). In the second and third pairs the inner branches are three-jointed, but considerably shorter than the outer branches; in each of the inner branches the first joint bears one and the second and third two moderately elongated plumose setæ, in addition to two small sabre-like terminal spines

(fig. 26). In the fourth pair the inner branches are two-jointed, and not much more than half the length of the outer branches; a moderately long plumose seta springs from the inner margin of the first joint, and three similar setæ from the inner margin of the second joint; the inner branches are also provided with two small apical spines (fig. 27).

Remarks.—It is probable that the species described above may be new to science, as it does not agree very satisfactorily with any described species known to me; but in the meantime I prefer to place it under the *Botryllophilus ruber* of Hesse, with which it agrees in some of its more characteristic features.

HARPACTICIDÆ.

Longipedia minor, T. and A. Scott.

Specimens of this Copepod were obtained in a gathering collected at 72 fathoms in the Sound of Mull, on March 31st, 1900. There can be no reasonable doubt as to there being two distinct forms of *Longipedia*, a larger (*L. coronata*, Claus), and a smaller (*L. minor*, T. and A. Scott), for ova-bearing females of both are occasionally obtained. Whether the smaller form should be regarded as a species or a variety is a question that is comparatively unimportant; the two terms are in not a few instances convertible, as their use depends to a large extent merely on one's opinion as to the value that should be placed on certain observed differences either in structural details or otherwise.

Canuella perplexa, T. and A. Scott.

This fine species was obtained in tow-net gatherings collected in Dornoch Firth, near Muckle Ferry, on May 19th, 1900. This is a new station for *Canuella perplexa*.

Eucanuella, T. Scott (gen. nov.).

Eucanuella is, in some respects, not unlike *Longipedia*, Claus, but is somewhat intermediate in structure between that genus and *Canuella*. *Eucanuella* differs from both of the genera named in the structure of the antennæ, of the maxillæ and of the second maxillipedes, and to some extent in that of the first thoracic feet; it agrees with *Canuella* in the structure of the second, third, and fourth pairs of feet, and to some extent in that of the first pair, but differs in that of the fifth pair; it agrees with *Longipedia* in the structure of the third, fourth, and fifth pairs of thoracic feet, and to some extent in that of the first pair, but differs in that of the second pair. As there is but the one species of *Eucanuella*, a detailed description of the various points referred to will be found in the specific definition.

Eucanuella spinifera, T. Scott (sp. n.). (Pl. XVIII., figs. 1–10.)

Description of the female.—Body elongated, moderately stout, gradually tapering towards the extremity of the abdomen; length, 1·33 mm. (about $\frac{1}{19}$ of an inch). The forehead terminates in a broadly conical rostrum, the apex of which is rounded. The first cephalothoracic segment is about as long as broad, and equal to fully the entire length of the remaining segments of the thorax, which are all moderately short. The posterio-lateral angles of the fourth joint of the thorax and the first joint of the

abdomen are produced backward into distinct tooth-like processes. The caudal furca are moderately stout and rather longer than the last abdominal segment (fig. 1).

The antennules are short and seven-jointed, and also moderately setiferous; the first four joints are moderately large and tumid, but the last three are very small; the second joint is armed with a short conical tooth on its exterior aspect, and a stout and elongated plumose seta springs from the interior distal angle of the fourth joint (fig. 2). The formula shows the proportional lengths of the joints of the antennules:—

Numbers of the joints, . . .	1	2	3	4	5	6	7
Proportional lengths of the joints, .	13	7	16	9	4	4	9

The antennæ.—The primary branches of the antennæ are three-jointed, the joints, which are sub-equal in length, are moderately elongated, a secondary four-jointed branch is articulated to the distal end of the first and is nearly equal to it in length; the last three joints of the secondary branches are small and their entire length scarcely exceeds that of the preceding joint. Both branches of the antennæ are provided with a number of plumose setæ of moderate length (fig. 3). In *Longipedia* and *Canuella* the antennæ differ from those just described, not only in the character of the basal joints and in the manner in which the secondary branches are hinged to them, but also in the secondary branches, in both being six- instead of four-jointed.

The mandibles are moderately stout, sub-cylindrical, and truncate at the apex, each mandible is armed with several coarse apical teeth, and provided with a well-developed two-branched palp; the branches of the palp are supported on a slightly tumid basal joint; the terminal branch appears to be uniarticulate, but the posterior branch is composed of about four joints, the three end ones of which are minute, both branches are moderately setiferous (fig. 4).

The maxillæ are each furnished with a distinct manducatory lobe armed with several moderately long and awl-shaped apical spines; the palp is obscurely two-branched and turned toward the same side as the manducatory process, it is also furnished with a number of slender and moderately elongated setæ (fig. 5).

The first maxillipedes are robust and somewhat similar in structure to those of *Canuella* (fig. 6).

The second maxillipedes are smaller than the first pair, and are apparently four-jointed; the first joint is larger than the other three combined, but the third and fourth are very small. These maxillipedes are armed with several stout and spiniform marginal setæ and two or three elongated spines, two spines at the end and on the inner aspect of the first joint have a fringe of minute hairs along the interior edge, while another at the end of the second joint is lancet-shaped, and has both margins of the distal half minutely serrated (fig. 7).

The thoracic feet.—The first four pairs of thoracic feet are each composed of two branches, and both branches are three-jointed. The outer branches of the first pair are considerably more elongated than the inner branches, and they are also more robust, they are armed with moderately elongated, stout, and spiniform marginal and terminal setæ; a single and somewhat slender plumose seta also springs from the inner margin of each of the three joints of the outer branches, as shown in the figure (fig. 8). The inner branches are not much more than half the length of the outer ones, they are composed of three subequal and sparingly setiferous joints; the inner distal angles of the first and second joints are continued into

tooth-like projections. A strong spine with ciliated edges extends downwards from the interior distal angle of the second basal joint of the first pair. The second, third, and fourth pairs are very similar to the same appendages in *Canuella*, in each pair the length of the inner and outer branches is subequal and both are slender and elongated (fig. 9). The fifth pair are somewhat like those of *Longipedia*, in each foot the basal joint is almost rudimentary, and consists of a narrow plate which extends laterally outwards into a small cylindrical lobe, bearing at its apex an elongated and slender plumose seta; the secondary branch is elongate-narrow and sub-cylindrical, about four times longer than broad, and furnished with one long and plumose terminal seta and a sub-terminal and shorter one; a small seta also springs from near the middle of the outer margin. Interiorly the basal joint is not produced, nor does it appear to carry either spines or setæ (fig. 10).

Habitat.—Found in the stomach of a small Haddock captured about sixty-five miles south-eastward of Sumburgh Head, Shetland, September 4th, 1900. Obtained also in some bottom material collected with a tow-net about fifty miles south-eastward of the Fair Island, between Orkney and Shetland, October 19th, 1900. The tow-net had touched the bottom, and when hauled up was found to contain a quantity of sand, amongst which were several rare Crustaceans. The vessel on which these collections were made was the steam trawler "St. Andrew," of Aberdeen.

Remarks.—The species described above, while agreeing in some respects both with *Longipedia*, Claus, and *Canuella*, T. and A. Scott, presents too many points of difference to permit of its being ascribed to either of these two genera. I have already drawn attention to the fact that the secondary branches of the antennæ in *Eucanuella* are only four-jointed, whereas in *Canuella* and *Longipedia* the secondary branches are composed of six joints; and it has also been shown that the second maxillipedes in *Eucanuella* are more fully developed than they are in either of these two genera. It has also to be noted that whereas in *Eucanuella* in the branches of the second pair of thoracic feet the inner and outer branches are about equal in length, the inner branches of the same pair in *Longipedia* are remarkably elongated; and, further, in *Eucanuella* the fifth pair of feet have the secondary joint moderately developed and somewhat similar in form and armature to the fifth pair in *Longipedia*, but in *Canuella* the fifth pair are quite rudimentary. There are other points of difference, but these are quite sufficient to distinguish *Eucanuella* from either *Canuella* or *Longipedia*, to which it is no doubt closely allied.

Bradya typica, Boeck.

This species was obtained in material dredged in the Moray Firth, and examined during last year.

Bradya hirsuta, T. and A. Scott.

One or two specimens of this distinct species were obtained in the same gathering as the last; it is a moderately large species with strongly divergent caudal furca.

Bradya elegans, T. and A. Scott.

This species has not only been observed in the Moray Firth along with the others just referred to, but it has also been obtained in material dredged by the "Garland" in Loch Eil, at the head of Loch Linnhe, in 10 to 15 fathoms, on the 3rd of April last year.

Brayda similis, T. and A. Scott.

Bradya similis has been obtained during the past year in material dredged by the "Garland," both in the Moray Firth and in 45 fathoms off Aberdeen; this species is considerably smaller than *Bradya hirsuta*, but the caudal furca are, as in that species, distinctly divergent.

Tachidius littoralis, Poppe (1881). [=*T. crassicornis*, T. Scott (1892).]*

This small species, distinguished at first sight from *T. brevicornis* by its short, stout antennules, which terminate so abruptly that they appear as if the ends had been broken off, was found in the store-pond of the Sea-Fish Hatchery at Bay of Nigg. It is a littoral species, and its presence in the store-pond seems to indicate that it may also occur in the Bay. It was observed in the pond on November 29th, 1900.

Zosima typica, Boeck.

This species was obtained in some material dredged in Loch Eil, at the head of Loch Linnhe, on April 3rd, 1900. It has also been obtained during the past year in a gathering of Crustacea from the Moray Firth forwarded from the "Garland."

Stenhelia hispida, G. S. Brady.

This fine species occurred in the same gathering from Loch Eil in which the *Zosima* was obtained; although the species appears to have a fairly extensive distribution, and is occasionally obtained in moderate numbers, it seems nevertheless to be somewhat local.

Stenhelia intermedia, T. Scott.

This species, which was described in Part III. of the Fifteenth Annual Report from specimens obtained in Kilbrennan Sound, Firth of Clyde, has been obtained also in the Moray Firth, having occurred very sparingly in some dredged material sent from the "Garland."

Ameira longipes, Boeck.

This does not appear to be a very common form, and I have only occasionally met with it. Its distribution, however, seems to be moderately extensive; it was obtained in a gathering of dredged material collected at 72 fathoms in the Sound of Mull, March 31st, 1900, and forwarded from the "Garland" to the Laboratory at Bay of Nigg.

Laophonte intermedia, T. Scott.

A number of *Laophontes* have been observed during the past year. *L. intermedia* is a distinct and moderately rare species, and I have now to record its occurrence in the Bay of Nigg, near Aberdeen, where it was obtained on October 1st, 1900.

Laophonte denticornis, T. Scott.

This species, which is also moderately rare, was dredged from 72 fathoms in the Sound of Mull, March 31st, 1900. The specimens from which the species was described were dredged off St. Monans, Firth of Forth, in 1893.

* *Tenth Ann. Rept. Fishery Board for Scotland*, Part III., p. 250, Pl. VIII., figs. 14–27 (1892).

Cletodes linearis, Claus.

This was contained in a gathering of Clyde Crustacea dredged between Sanda and Bennan Head on November 3rd, 1896, but only recently examined. The species seems to be rare in the British seas.

Cletodes monensis, I. C. Thompson.

This somewhat curious species was first made known to science by Mr. I. C. Thompson, of Liverpool, in 1893.* Some time afterwards, but also in the same year,† I recorded its occurrence in the Moray Firth, where, along with some other rare Crustaceans, it had been obtained by washing lumps of *Filograna implexa*, which had been brought up in the net of the shrimp-trawl from a depth of about 40 fathoms, about five to seven miles to the northward of Rosehearty. On the present occasion I have again to record *Cletodes monensis* from the Moray Firth, but this time at about thirteen or fourteen miles north-east of Buckie; it occurred along with some other interesting Crustaceans in a gathering collected by tow-net which had touched bottom at 50 to 55 fathoms, November 3rd, 1900. (This gathering was from the steam trawler "St. Andrew.") I have also to record the same interesting species from the head of Loch Eil (at the upper end of of Loch Linnhe), where it was dredged by the "Garland" in 8 to 10 fathoms on April 3rd last year. This is the first time *Cletodes monensis* has been recorded from the West of Scotland.

Cletodes hirsutipes, T. Scott.

This species was described in Part III. of the Fifteenth Annual Report (1897), from Clyde specimens. I have now to note its occurrence in the Moray Firth in some dredged material collected off Nairn in 1898, but only recently examined. One peculiarity by which this species may be distinguished is the character of the fifth thoracic feet, the secondary joints of which are lamelliform, and of a narrow-oblong outline; their outer edges are fringed with a dense border of short hairs, but this fringe is frequently so coated with mud that it becomes necessary to clean it ere it can be clearly made out.

Cletodes perplexa, T. Scott.

This is a small species, but of so marked a character as to be readily distinguished without dissection; it was described in 1899 in Part III. of the Seventeenth Annual Report from specimens dredged by the Fishery steamer "Garland" at Smith Bank, Moray Firth. I have now to record the species from the head of Loch Eil; it occurred in the same gathering in which *Cletodes monensis* was obtained. It was collected on April 3rd, 1900.

Cletodes irrasa, T. and A. Scott.

This appears to be a somewhat rare species in the Copepod fauna of Scotland, and I have obtained it in only one or two localities; it was described from specimens obtained near the Bass Rock, Firth of Forth, in 1893. It has more recently been obtained in the Clyde, and I have now

* Revised Report on the Copepoda of Liverpool Bay (*Trans. L'pool. Biol. Soc.*, vol. vii., 1893), p. 26, Pl. XXXIV.

† *Ann. and Mag. Nat. Hist.*, (6), vol. xii., p. 243 (Oct. 1893). (*Cletodes monensis* was here by a slip recorded as *Laophonte monensis*, but the error was rectified in a paper published in the *Ann. and Mag. Nat. Hist.* in the following February.)

to add another station for it—viz., Loch Eil (off Loch Linnhe)—where it was dredged along with *Cletodes monensis* and *Cletodes perplexa* on April 3rd, 1900.

Pseudothalestris major (T. and A. Scott).

This somewhat rare species was obtained in the store-pond of the Sea-Fish Hatchery at Bay of Nigg in August, 1900.

Cervinia bradyi, Norman.

This interesting and well-marked species was obtained in the same gathering with *Cletodes monensis* referred to above, collected 13 or 14 miles north-east of Buckie, Moray Firth, in 50 to 55 fathoms, November 3rd, 1900. This is the second time that *Cervinia* has been taken in the Moray Firth; it was taken the first time about five to seven miles off Rosehearty, in 1893, and at that time it was also associated with *Cletodes monensis*.

Zaus goodsiri, G. S. Brady.

This fine species was collected in 45 fathoms off Aberdeen, on November 7th last year, by the Fishery steamer "Garland." The gathering in which the *Zaus goodsiri* occurred contained a remarkable assemblage of rare and interesting Crustacea; they comprised nearly fifty species, and included many genera, and nearly all the more important groups were represented—viz., the Copepoda, Amphiphoda, Isopoda, Sympoda, Schizopoda, and the Macrura.

Peltidium purpureum, Philippi.

This species was added to the British fauna in 1886; it was obtained at Tarbert, Loch Fyne, during some investigations carried on there under the direction of the Fishery Board for Scotland. Though *Peltidium purpureum* has since that time been observed in one or two other parts of Loch Fyne and the Clyde estuary, it does not appear to have been recorded from any other district of Scotland. In the present paper, however, I am able to add two new stations for this *Peltidium*, both of which are on the West Coast—viz., Loch Etive, off Abbot's Island, in a gathering dredged at 9 fathoms on March 30th, 1900, and in a gathering collected a few days later at from 8 to 10 fathoms near the head of Loch Eil (off Loch Linnhe). Both these gatherings were collected by the "Garland," and forwarded to the Laboratory at Bay of Nigg.

Alteutha purpurocincta, Norman.

This fine species was collected in Lerwick Harbour, Shetland, by the steam trawler "St. Andrew," October 14th, 1900. Rev. A. M. Norman collected this species at Hillswick, Shetland, in 1868.*

Idya cluthæ, T. Scott.

This species, which appears to be a deep-water form, was described in 1899 from specimens which had been obtained in Loch Fyne at from 50 to 70 fathoms, and in the Clyde at over 40 fathoms.† The same species of *Idya* was recently observed in a tow-net gathering from the Moray Firth

* *Report Brit. Assoc.*, 1868, p. 298.

† *Seventeenth Annual Report of the Fishery Board for Scotland* (1899), Part III., p. 260, Pl. XII., figs. 2–6

collected about thirteen to fourteen miles north-east of Buckie, in 50 to 55 fathoms, November 3rd, 1900. *Idya cluthæ* is quite distinct from any other species of *Idya*. The difference in the armature of the first thoracic feet and of the form of the fifth pair is marked, and are of themselves sufficient for distinguishing the species.

Idya minor, T. and A. Scott.

A few specimens of this *Idya* were obtained in a gathering of Copepods collected in the store-pond of the Sea-Fish Hatchery at Bay of Nigg, in August, 1900. They occurred amongst crowds of *Idya furcata*, and were readily distinguished by their small size. The same species was obtained in a gathering collected by hand-net in the Bay of Nigg on October 1st.

Idya longicornis, T. and A. Scott.

This species was obtained in Lerwick Harbour, Shetland, in the same gathering with *Alteutha purpurocincta* already referred to. The occurrence of *Idya longicornis* here extends the distribution of the species considerably.

Synatiphilus luteus, Canu and Cuénot.

1892. *Synatiphilus luteus*, Canu and Cuénot, Commens. paras. Echinod., *Rev. Biol. du Nord de la France*, Oct. 1872, p. 19, Pl. T., figs. 6, 7.

1893. *Remigulus tridens*, T. and A. Scott, Ann. and Mag. Nat. Hist. (6), vol. xii., p. 242, Pl. XI., figs. 15–20; Pl. XII., figs. 1–3.

This species occurred in some dredged material collected near the head of Loch Eil (off Loch Linnhe), in 10 to 15 fathoms, April 3rd, 1900. *S. luteus* was added to the British fauna in 1893 as a new species under the name of *Remigulus tridens*, from specimens collected near the mouth of Loch Spelve, Island of Mull, in 1892 (but not recorded till the following year). As the species, however, had already been described by Canu and Cuénot, as indicated above, the name *Remigulus tridens* necessarily becomes a synonym. So far as I know, *Synatiphilus luteus* has not been obtained anywhere else in Scotland than in the district of Loch Linnhe. It seems to be a rare species.

Corycæidæ.

Corycæus anglicus, Lubbock. (Pl. XVIII., fig. 11.)

In my paper on tow-net gatherings published in the Eighteenth Annual Report, Part III., I recorded *Corycæus anglicus* from the Firth of Clyde, and submitted a description of the species, which was illustrated by a number of figures; these figures were prepared from a female specimen, as no males had been observed. One of the gatherings which were collected during the investigations carried out on board the steam trawler "St. Andrew" was obtained while the vessel was proceeding along the south-east coast of Shetland between Lerwick and Sumburgh Head, and about seven miles off shore; the gathering was collected by passing the water from the donkey-pump through a fine tow-net. In this gathering, collected on October 16th, three specimens of a *Corycæus* were found, which I at first thought might be *C. obtusus*, Dana, as the genital segment of the abdomen possessed a small but distinct ventral hook at its proximal end,

similar to the hook observed in the male of that species (fig. 11); a further examination of the specimens showed, however, that they were the males of *C. anglicus*, Lubbock (fig. 11). *Corycæus anglicus* has also been obtained in a gathering from the Moray Firth, collected thirteen to fourteen miles north-east from Buckie, in 50 to 55 fathoms, on November 3rd, and in a gathering collected off Aberdeen in 45 fathoms on the 7th of the same month, but the specimens were females.

Lichomolgidæ.

Lichomolgus fucicolus (G. S. Brady).

One or two specimens of *L. fucicolus* occurred in a gathering collected in 72 fathoms in the Sound of Mull, March 31st, 1900.

Asterocheridæ.

Collocheres gracilicauda (G. S. Brady).

This species was obtained in some dredged material collected near the head of Loch Eil in 10 to 15 fathoms, April 3rd, 1900. *C. gracilicauda* is a moderately rare species, but it has apparently an extensive distribution. It has been recorded off the Yorkshire coast by Dr. Brady, from the Liverpool Bay district by Mr. I. C. Thompson, and also from the Firth of Forth; Dr. Canu has obtained it in the neighbourhood of Boulogne, and Dr. Giesbrecht in the Bay of Naples.

Incerta sedis.

Cancerina, T. Scott (gen. nov.).

Description of the genus.—Antennules short, six-jointed. Antennæ small, and simple in structure, not fitted for grasping. Mandibles narrow and of moderate length, toothed on the distal half of the inner margins, and somewhat like the mandibles of *Lerneopoda*. First maxillipedes somewhat rudimentary, unprovided with terminal spines or claws. Second maxillipedes large and strong, armed with stout but very short terminal claws. Thoracic feet, two pairs, they both are somewhat alike, and each foot consists of a single biarticulated branch. As there is but the one species a detailed description will be found in the specific definition.

Cancerina confusa, T. Scott (sp. n.). (Pl. XVIII., figs. 12–20.)

Description of the female.—The length of the specimen represented by the figure is fully 1 mm., from the forehead to the end of the caudal furca. The cephalothorax, seen from above, is sub-rhomboidal in outline. The cephalic segment is small, but moderately distinct; it is very short, being scarcely half as long as it is broad. The thorax, which appears to be unsegmented, is widest at about one-fourth of its length from the anterior end; from the widest part, the thorax, on each side, tapers towards both ends, the front slope is short and terminates at the cephalic segment, the posterior slope, which is longer and slightly sinuate, extends to the genital segment of the very short abdomen; this segment is moderately broad, rather more so than the posterior part of the thorax to which it is adjacent; the remaining segment of the abdomen is very small, and the caudal furca, which are short, are placed

somewhat widely apart. The ovisacs are very large, and the point at which they are attached to each side of the genital segment is nearer their posterior than their anterior ends; they thus occupy a rather peculiar position in relation to the body of the Copepod; the ovisacs are of an elongate-oval form, and from the peculiar manner in which they are attached to the genital segment, they extend forward along each side of the body of the Copepod instead of backwards, as in the majority of Copepods which carry two ovisacs. It was the peculiar position of the ovisacs that attracted my attention to this specimen, (fig. 12).

The antennules are short and six-jointed, the second joint is considerably longer than any of the others; the formula shows the proportional lengths of all the joints:—

Numbers of the joints,	1	2	3	4	5	6
Proportional lengths of the joints	14	24	17	12	13	10

The joints are sparingly setiferous, and taper very gradually from the proximal to the distal end (fig. 14).

The antennæ are very small, they each consist of a single two-jointed branch, armed with about six terminal setæ; the three middle setæ are moderately elongated, but the others are short; the joints of the antennæ are sub-equal and nearly three times longer than broad (fig. 15).

The mandibles have a remarkable resemblance to those of the Lernæopodidæ; they are moderately elongated, narrow, and somewhat cylindrical; they taper slightly from about the middle of the distal extremity, the inner margin is denticulate from about the middle to the apex of the mandible (fig. 16).

The maxillæ are very rudimentary; they are somewhat papilliform, and furnished with about four moderately stout spines (fig. 17).

The first maxillipedes are moderately stout, but of a somewhat rudimentary structure; they appear to be each composed of two joints, the first is comparatively tumid, the second is smaller and terminates in a boldly rounded apex finely serrated on the margin (fig. 18).

The second maxillipedes are large and strong; they are each composed of two joints, the basal joint is considerably larger than the other, the second is armed with a short but stout claw, the margin of which is convex and fits into a corresponding hollow in the joint to which it is articulated (fig. 19).

Thoracic feet.—There appear to be only two pairs of thoracic feet, which are similar to each other in size and structure. They appear to be each composed of a single two-jointed branch of moderate length, furnished with two somewhat elongated and two or three very small setæ (fig. 20). The position of the thoracic feet is somewhat abnormal; one pair is almost in line with, and outside of the second maxillipedes, the other pair occupy a somewhat intermediate position and somewhat further forward, as shown in figure 13.

Habitat.—Dredged at Tarbert Bank, Lower Loch Fyne, in 17 to 20 fathoms, October 28th, 1899. One specimen only—a female—was observed.

Remarks.—This somewhat curious Copepod, which I have now tried to describe, is in some respects not very unlike *Cancerilla tubulata*, Dalyell. It has a somewhat similar squat form, large ovisacs, and short six-jointed antennules; while, as regards the form of the mandibles and maxillæ, and especially of the latter, the disparity is not very great; it is only in the structure of the antennæ, the maxillipedes, and the thoracic feet that the most marked differences are observed. The antennæ are

simple in structure and do not form grasping organs as in *Cancerilla*; the maxillipedes are more rudimentary; and the thoracic feet, of which there appear to be only two pairs, are each composed of two moderately stout basal joints and a single biarticulated branch; in *Cancerilla* the first and second pairs of feet, though two-branched, are more rudimentary than those of *Cancerina*, and the third and fifth pairs, though present, are also rudimentary.

In consequence of these differences I have considered it necessary to institute a new genus for this Copepod, and, from its general resemblance to the *Cancerilla* of Dalyell, have given to it the name of *Cancerina*.

Nicothoidæ.

Nicothoë astaci, Aud. and M.-Edw. (Pl. XVII., figs. 35–39; Pl. XVIII., figs. 21–26.)

1826. *Nicothoë astaci*, Aud. and M.-Edw., Ann. Sci. Nat., (1), vol. ix., p. 345, Pl. 49, figs. 1–9.
1850. *Nicothoë astaci*, Baird, Entom., p. 307, Pl. XXXIII., fig. 11.

Description of the female.—The length of the specimen represented by the drawing is 1·5 mm. (about $\frac{1}{17}$ of an inch), exclusive of the caudal setæ. The body is cyclopoid in its general outline, but the two great wing-like lateral expansions of the posterior part of the thorax destroy the symmetrical appearance of the animal. These expansions appear to be the result of an extraordinary development of the fourth segment of the thorax. The three segments intermediate between this one and the cephalic segment are very narrow; they are represented on the dorsal aspect by more or less distinct articulations as shown in the drawing, while in front of the cephalic segment two distinct eyes can be observed. The abdomen is composed of four segments, the genital segment is somewhat dilated and rather longer than the combined lengths of the next two segments. The caudal furca are very short, and each is furnished with an elongated and moderately stout terminal seta and a few minute hairs. The two ovisacs are very large. (Pl. XVII., fig. 39, and Pl. XVIII., fig. 21.)

The antennules are of moderate length and sparingly setiferous, they are composed of eleven joints, but, with the exception of the second and last, all the joints are small (Pl. XVIII., fig. 35). The formula shows approximately the proportional lengths of all the joints:—

Numbers of the joints,	1 . 2 . 3 . 4 . 5 . 6 . 7 . 8 . 9 . 10 . 11
Proportional lengths of the joints,	11 . 33 . 13 . 10 . 10 . 10 . 10 . 10 . 10 . 10 . 20

The antennæ are small but moderately stout, and appear to be composed of four joints, the basal joint is considerably larger than the others; each antenna is armed with two moderately strong apical spines, and as the end-joint to which they are attached is hinged at nearly a right angle to the preceding joint, the antennæ become, with the assistance of the apical spines, effective grasping organs; the third joint is provided with a curved and somewhat lamelliform plate, which may be a sensory appendage (Pl. XVIII., fig. 36).

The mandibles are long and slender, slightly incurved, and tapering to a point (Pl. XVII., fig. 22).

The maxillæ are each composed of a moderately stout basal joint, and a

small and apparently two-jointed secondary branch, which is articulated to the inner edge of the basal joint; the basal joint is furnished with three strong terminal setæ of moderate length, plumose on the distal half; the secondary branch is armed with a few small terminal spines (Pl. XVII., fig. 37).

The first maxillipedes are small and apparently composed of two joints, of which the end-joints are the smallest, each maxillipede is armed with two moderately strong terminal claw-like spines, and as they are slightly curved inwards, they form, with the end-joint, a moderately powerful hook (Pl. XVII., fig. 38).

The second maxillipedes, which are larger than the first pair, are each composed of five joints, the first and second joints are of moderate size but the three end ones are small, the terminal claw-like spine is longer than the entire length of the three end joints (Pl. XVIII., fig. 23).

The thoracic feet.—The first four pairs of thoracic feet are all somewhat similar, they are each composed of a stout two-jointed basal part, which bears two sub-equal three-jointed branches at its distal end; the outer branches are armed on the exterior margin with several small, slender spines, while the inner margins of both branches are furnished with plumose setæ (Pl. XVIII., figs. 24 and 25). The fifth pair consist each of a single uniarticulated lamelliform branch, about three times longer than broad; each branch is provided with six small plumose setæ—one near the middle of the inner margin and five arranged round the apex (Pl. XVIII., fig. 26).

The ovisacs are very large and contain numerous ova. No males have yet been observed.

Habitat.—On the gills of a scarcely full-grown Lobster, captured by Mr. H. C. Williamson in Bay of Nigg, near Aberdeen, June 30th, 1900.

Remarks.—Though *Nicothoë astaci* appears to be moderately frequent on the gills of Lobsters captured on various parts of the English coast, I do not know of any previous authentic record of its occurrence in Scottish waters; Edward of Banff, who was so successful a collector of Crustacea, though he records the common Lobster in his list of Moray Firth species, does not appear to have observed the Copepod parasite which is so intimately associated with that Crustacean. *Nicothoë astaci* is no doubt frequently overlooked, and if a careful examination were made of the lobsters captured on our shores the distribution of the parasite in the Scottish seas might be found to be co-extensive with its host.

The *Nicothoë* seems to be a remarkably sluggish animal. Milne-Edwards —quoted by Dr. Baird*—states that "they allowed themselves to be torn to pieces without making the least movement or quitting their hold," and further, that though "taken carefully off the gills of the lobster with all possible precautions not to injure the animals, and placed in a glass of sea-water, though watched for several hours, and though they lived during that period, as might be seen by the peristaltic movement of the intestine, they made no attempt themselves at locomotion." I may add that my son has kept specimens of *Nicothoë* alive for five weeks in ordinary sea water, which was changed about once a week, and though they were carefully watched during that time he never saw them make any attempt to move about, and the only indication that they were alive was the persistence of their semi-transparent pinkish colour and the peristaltic movement of the alimentary canal. The parasite is usually brightly coloured, and, as it is of moderate size, is readily observed *in situ* when that part of the lobster's carapace which covers the gills is removed.

* British Entomostraca, p. 304.

CHONDRACANTHIDÆ.

Lamippe proteus, Claparède.

This curious little species is common on the *Alcyonium digitatum*, or "Dead-man's Fingers," so frequently brought up in the trawl-net or on fishermen's lines. A number of specimens were recently obtained on pieces of *Alcyonium* trawled by the "Garland" off Aberdeen. *Lamippe proteus* was first recorded from the Scottish seas in 1895 from specimens observed in the Firth of Forth.

Lamippe forbesi, T. Scott.

1896. *Lamippe* sp., T. Scott, Fourteenth Ann. Rept. of the Fishery Board for Scotland, Part III., p. 164, Pl. IV. figs. 9–12.

This distinct form was first observed in the Firth of Forth in the early part of 1896, and the same species was almost immediately afterwards found by my son in Liverpool Bay. At that time it was thought it might be a species which was already described, and it was therefore recorded as "*Lamippe* sp." *L. forbesi* seems to be a rare species, for, although the portions of *Alcyonium* recently examined yielded between two and three hundred specimens of *L. proteus*, only two specimens of *L. forbesi* were observed after a careful search. *L. forbesi* is a distinctly larger species than *L. proteus*.

Change of Name.

Genus *Eurynotopsyllus*, nov. nom. [= *Eurynotus*, T. and A. Scott (1898) preoccupied.]

In 1898 a new Copepod from the Clyde was described and figured by T. and A. Scott in the "Annals and Magazine of Natural History," s. 7, vol. i., p. 188, under the name of *Eurynotus insolens;* it was also recorded under the same name in Part III. of the Sixteenth Annual Report of the Fishery Board for Scotland (1898), p. 279. I have now ascertained that *Eurynotus* has already been twice used—viz., by Kirby in 1817 for a genus of Coleoptera, and by Agassiz in 1835 for a genus of fishes; as, therefore, the name cannot be retained for this Copepod I propose to change it for the altered form *Eurynotopsyllus* (*Eurynotus* plus *psyllus*, a flea).

Order 2, OSTRACODA.

BAIRDIIDÆ

Genus *Bairdia*, M'Coy (1849).

Bairdia inflata (Norman).

1862. *Cythere inflata*, Norman, Ann. and Mag. Nat. Hist., vol. xi., p. 49, Pl. iii., figs. 6-8.

1896. *Bairdia inflata*, Brady and Norman, "Mon. M. and F.-W. Ostrac. of the N. Atlantic and N.-W. Europe" (*Sci. Trans. Roy. Dublin Soc.*, vol. iv., s. ii., p. 112.

One whole specimen and a valve of this species occurred amongst some sand dredged in about 80 fathoms to the east of Fair Island in October last.

Genus *Macrocypris*, G. S. Brady (1868).

Macrocypris minna (Baird).

1850. *Cythere minna*, Baird, Brit. Entom., p. 171, t. xx., fig. 4, 4 a–d.

1868. *Macrocypris minna*, Brady, Mon. rec. Brit. Ostrac., p. 392, t. xxvii., figs. 5–8; t. xxxviii., fig. 4.

1889. *Macrocypris minna*, Brady and Norman, *op. cit.*, vol. iv., s. ii., p. 117.

This fine species was frequent in a tow-net gathering collected on the 19th October, 1900, in 80 to 85 fathoms, about fifty miles S.S.E. of Fair Island, between Orkney and Shetland. The tow-net had touched bottom, and when hauled up was found to contain a considerable quantity of mud, this was washed through the net and the material that remained in the net was preserved; mixed up in this material was a considerable number of *Macrocypris*. In the Monograph of the Marine and Fresh-water Ostracoda of the North Atlantic and North-Western Europe, the authors, referring to *Macrocypris minna*, say (*op. cit.*, p. 117) that "the only British locality for this species is Shetland, where a single specimen was dredged by MacAndrew forty years ago, and a second by A. M. N. on the outer Haaf in 1861."

CYTHERELLIDÆ.

Genus *Cytherella*, Jones (1849).

Cytherella abyssorum, G. O. Sars.

1865. *Cytherella abyssorum*, G. O. Sars, Overs. of Norg. marine Ostrac., p. 127.

1865. *Cytherella beyrichi*, G. S. Brady, "On New or Imperfectly Known Ostrac.," *Trans. Zool. Soc.*, vol. v., p. 362, Pl. lvii., figs. 3 a, b.

1866. *Cytherella scotica*, G. S. Brady, Brit. Assoc. Rept. (1866), p. 211.

1896. *Cytherella abyssorum*, Brady and Norman, *op. cit.*, vol. v., s. ii., p. 716, Pl. lxvi., figs. 1, 2, 5; Pl. lxvii., figs. 13, 14.

A single perfect specimen and a valve of this species were obtained in the same material with the last; *Cytherella abyssorum* seems to be a rare species in our seas, as the only Scottish record for it hitherto appears to be that of G. S. Brady, who, in his "Monograph of Recent British Ostracoda," states that two or three specimens were obtained by himself and the Rev. A. M. Norman amongst sand dredged by Mr. Jeffreys in 60 fathoms in the Minch.*

It may be mentioned in passing that the Foraminifer *Saccamina sphæra* was very common in this gathering; a few other Foraminifera, such as *Astrorhiza arenaria*, *Psammosphæra fusca*, and *Placopsilina bulla*, were also observed.

* *Trans. Linn. Soc.*, vol. xxvi., p. 473, Pl. xxxiv., figs. 18–21.

Sub-Class MALACOSTRACA.

Sub-Order AMPHIPODA.

LYSIANASSIDÆ.

Normanion quadrimanus (Bate and Westwood).

In the Seventeenth Annual Report, Part III., I recorded this rare species from near Davaar Island, Firth of Clyde. I have now to add another Clyde station for the species—viz., Tarbert Bank, Lower Loch Fyne, in 17 to 20 fathoms; it occurred in some material dredged on the Bank on December 22nd, 1899, but not examined till some time afterwards. Besides the two stations mentioned, *Normanion* has also been obtained off Cumbrae in 20 to 25 fathoms by the Rev. A. M. Norman.*

Acidostoma obesum (Bate).

I have to record this species from the Moray Firth, in a gathering collected in 1898 but only examined last year. Also in a gathering of Crustacea collected off Fair Island in October; and in another from 45 fathoms off Aberdeen, collected in November, 1900.

Perrierella audouiniana (Bate).

Dredged in 72 fathoms, Sound of Mull, March 31st, 1900; and in Loch Etive, off Abbot's Island, in 9 fathoms, on the 30th of the same month (Fishery steamer "Garland").

Orchomene humilis (A. Costa).

Orchomene humilis was obtained in Loch Etive in the same gathering with *Perrierella audouiniana*. This is the *Anonyx edwardsii* of Bate and Westwood's "Sessile-eyed Crustacea" and the *Orchomene batei* of G. O. Sars' "Crustacea of Norway."†

Tryphosella horingii (Boeck).

This species occurred in a tow-net gathering collected about fifty miles south-eastward of the Fair Island, in October, 1900, and in moderately deep water.

Anonyx nugax (Phipps).

Quite recently several specimens of *Anonyx nugax* (Phipps) were forwarded to the Laboratory at Bay of Nigg, from Mr. F. G. Pearcey, the Naturalist on board the Fishery steamer "Garland." They were collected in the Cromarty Firth in 7½ fathoms on January 10th, 1901. This is only the second time I have seen *Anonyx nugax* in Scottish waters, and the first time in the Moray Firth district. The previous occurrence of the species was in 1889, when it was obtained near May Island in the Firth of Forth in the month of February, but was not recorded till 1893.‡ It may be of interest to note that on the present occasion the specimens have been obtained a month or so earlier than they were observed in 1889.

**Ann. and Mag. Nat. Hist.*, (7), vol. v., p. 141 (1900).
† Norman, *op. cit.*, p. 202.
‡ *Eleventh Ann. Rept. of the Fishery Board for Scotland*, Part III., p. 212, Pl. V., figs. 18–21 (1893).

Lepidepecreum longicorne (Bate).

This species was dredged by the "Garland" in 45 fathoms off Aberdeen on November 7th, 1900.

Euonyx chelatus, Norman.

This somewhat rare species was obtained in some material dredged by the "Garland" in 32½ fathoms on October 12th, 1900; and in a bottom tow-net gathering from the steam trawler "St. Andrew," collected about fifty miles south-eastward of the Fair Island, in 70 to 80 fathoms, on the 19th of the same month. Only one or two specimens were obtained in either gathering.

PONTOPOREIIDÆ.

Bathyporeia norvegica, G. O. Sars.

Obtained in a bottom tow-net gathering collected about fifty miles south-eastward of Fair Island, October 16th, 1900.

Argissa hamatipes, Norman.

Specimens of *A. hamatipes* occurred in gatherings collected off Aberdeen in June, and off Fair Island, collected October 12th, 1900.

PHOXOCEPHALIDÆ.

Phoxocephalus fultoni, T. Scott.

A few specimens of this species were obtained in material dredged in Loch Etive off Abbot's Island, in 9 fathoms, March 30th, 1900. The same species has been dredged in Loch Ryan, near the mouth of the Clyde, as well as in the Clyde itself.

Phoxocephalus oculatus. G. O. Sars.

This form occurred with several other Crustaceans in some dredged material collected in the Sound of Mull, in 72 fathoms, March 31st, 1900. So far as the male of *Phoxocephalus oculatus* is concerned, there is little danger of confounding it with *Phoxocephalus holbölli* (Kröyer). The large and conspicuous black eyes are sufficient of themselves to attract the attention of the observer; it was collected by the Fishery steamer "Garland."

AMPELISCIDÆ.

Ampelisca spinipes, Boeck.

This fine species was obtained off Aberdeen in a gathering from 45 fathoms collected November 7th, 1900 (Fishery steamer "Garland.")

Ampelisca macrocephala, Lilljeborg.

This species occurred in one or two of the gatherings collected off Fair Island on the 12th and 19th October, 1900.

Ampelisca brevicornis (A. Costa).

According to Norman, the *A. lævigata* of Lilljeborg is identical with *A. brevicornis* (A. Costa), and, as this name is prior to the other, *A*

lævigata must be set aside. The species known as *Ampelisca lævigata*, Lilljeborg, was dredged during the past year in Loch Etive, near Abbot's Island, in 9 fathoms, on March 30th.

Byblis gaimardi (Kröyer).

A single specimen of this rare species was obtained in a bottom tow-net gathering collected about fifty miles S.S.E. of Fair Island at a depth of about 80 fathoms on October 12th, 1901. There appear to be extremely few British records of *Byblis gaimardi*. Norman gives the following three:—Off Seaham, Co. Durham; off St. Abbs Head, 40 fathoms; and near May Island, Firth of Forth (1890).* The latter seems to be the most recent British record of the species previous to the present one.

AMPHILOCHIDÆ.

Amphilochoides odontonyx, Boeck.

This species was obtained in a tow-net gathering collected about sixty-five miles east by south off Sumburgh Head, Shetland, September 4th, and about fifty miles south-south-east of Fair Island, October 16th, 1900. This is the form described by G. O. Sars under the name of *Amphilochoides pusillus*.

Amphilochoides intermedius, T. Scott.

One or two specimens of *Amphilochoides intermedius* occurred in some material dredged off Aberdeen in forty-five fathoms, November 11th, 1900. This species was described in 1896 in the Fourteenth Annual Report of the Fishery Board for Scotland, Part III., p. 159, Pl. IV., figs. 1–3.

Stegoplax brevirostris (T. and A. Scott).

Several specimens of this small species were obtained in the same gathering in which *Amphilochoides intermedius* occurred, collected in 45 fathoms off Aberdeen. This species was ascribed by T. and A. Scott to the genus *Cyproidia*,† but the Rev. A. M. Norman refers it to *Stegoplax* because the upper antennæ have no secondary appendage.‡

METOPIDÆ, Stebbing (1899).

Metopa rubrovittata, G. O. Sars.

This small, brightly red-coloured species occurred in a gathering collected sixty-five miles east by south of Sumburgh Head, Shetland, and in another collected off Fair Island; the first was collected in September and the other in October, 1900.

Metopa borealis, G. O. Sars.

This species was obtained in a gathering collected in Aberdeen Bay on June 28th, 1900.

Metopa norvegica (Lilljeborg).

This is the *Metopa pollexiana* of Bate and Westwood; several specimens of this fine species were obtained in a few of the gatherings collected off

* British Amphipoda; *Ann. and Mag. Nat. Hist.*, (7) vol. v., p. 344 (1900).
† *Ann. and Mag. Nat. Hist.*, (6), vol. xii., p. 244, Pl. XIII., figs. 1–11 (1893).
‡ British Amphipoda; *Ann. and Mag. Nat. Hist.*, (7), vol. vi., p. 38 (1900).

Aberdeen, in October and November last year. The species occurred in a gathering from 36 to 49 fathoms collected on October the 23rd, in another from 60 fathoms collected on the 25th of the same month, and in a third gathering from 45 fathoms collected on November 7th. These gatherings were collected by the Fishery steamer "Garland."

Metopella nasuta (Boeck).

This small species was moderately common in a gathering collected off Fair Island, in 80 to 85 fathoms, on October 12th, 1900. It was also obtained in some bottom tow-net material, collected about sixty-five miles to the south-east of Sumburgh Head, on September 4th, by the steam trawler "St. Andrew."

Metopina robusta (G. O. Sars).

This somewhat rare species occurred in one of the gatherings from the Fishery steamer "Garland," collected off Aberdeen, in 45 fathoms, November 7th, 1900. The Rev. A. M. Norman has instituted the new genus—*Metopina*—for this form,* and one of its principal characters is the peculiar structure of the first gnathopods. There appear to be only three British records for *Metopina robusta* previous to this one, viz. :—The Firth of Forth, where it was obtained by Dr. Henderson in 1884, and the Moray Firth, where it was dredged by the "Garland" in 1893,† and again in 1899.‡ The gathering in which it occurred in 1893 was collected a few miles to the north of Rosehearty, but the gathering collected in 1899 was from Station XV., in the vicinity of Smith Bank.

LEUCOTHOIDÆ.

Leucothoë lilljeborgii, Boeck.

This was obtained in a tow-net gathering collected about fifty miles south-south-east of Fair Island, October 16th, 1900. There does not appear to be any previous record of *L. lilljeborgii* from this part of the North Sea.

ŒDICERIDÆ.

Aceros phyllonyx (M. Sars).

Although a number of species belonging to the Œdiceridæ have been observed in the various tow-net gatherings examined, and notes taken of them, they are rather more common than the one specially referred to. *Aceros phyllonyx* appears to be comparatively rare as a British species; the only British record known to me is that of Metzger of the German North Sea Expedition, who obtained it "sixty miles north of Peterhead." During the Fishery Board's recent investigations eastward of Fair Island, *Aceros* was obtained on two occasions in bottom tow-net gatherings, collected on the 12th October about fifty miles south-south-east of Fair Island, in 80 to 85 fathoms. A number of specimens were obtained, but all were more or less damaged; they were, however, sufficiently perfect for identification.

* British Amphipoda; *Ann. and Mag. Nat. Hist.*, (7), vol. vi., p. 45 (1900). It has to be noted, however, that *Metopina* has already been used by Macquart for a genus of insects.

† *Ann. and Mag. Nat. Hist.*, (6), vol. xiii., p. 148 (1894).

‡ *Seventeenth Ann. Rept. of the Fishery Board for Scotland*, Part III., p. 265.

PLEUSTIDÆ.

Paramphithoë monocuspis, G. O. Sars.

This species and the closely-allied form *Paramphithoë bicuspis* were obtained in gatherings collected off Fair Island in October, and in one collected off Aberdeen in 45 fathoms, November 7th, 1900. In the gathering collected off Aberdeen *P. monocuspis* was much more frequent than the other.

Sympleustes latipes (M. Sars). (= *Amphithoë latipes*, M. Sars.)

A few specimens of this species were obtained in a bottom gathering of Crustacea collected by the "Garland" off Aberdeen in 60 fathoms, October 25th, 1900.

EPIMERIDÆ.

Epimeria cornigera (Fabricius).

This fine species was moderately frequent in some material collected by the "Garland" off Aberdeen in 32½ fathoms, October 12th, 1900; one or two of the specimens in this gathering were of a nearly white colour. *Epimeria cornigera* was also moderately frequent in some of the gatherings collected eastward of Fair Island in the same month.

EUSIRIDÆ.

Eusirus longipes, Boeck.

This was dredged by the "Garland" in the Sound of Mull in 72 fathoms, on March 31st, 1900; it also occurred in some material collected by the "Garland" off Aberdeen in 32½ fathoms on October the 12th, and again on October 23rd in 36 to 49 fathoms; in this last gathering the species was moderately frequent.

CALLIOPIIDÆ.

Apherusa borealis (Boeck).

This was moderately frequent in material collected in Aberdeen Bay on June 28th. Another species—*Apherusa bispinosa* (Bate)—was obtained in a gathering collected off Aberdeen in 60 fathoms, on October 25th; while a third species—*Apherusa furinii* (M.-Edw.)—was obtained in a gathering of Crustacea collected in Bay of Nigg with a hand tow-net and rowing-boat by Mr. Williamson, July 27th (1900).

ATYLIDÆ.

Paratylus uncinatus, G. O. Sars.

This is the species which has no projections on the dorsum, but which otherwise somewhat resembles *Paratylus falcatus* (Metzger). *P. uncinatus* occurred in some material collected in Aberdeen Bay on June 28th, and also in the same gathering from Bay of Nigg which Mr. Williamson collected on July 27th, 1900. The species was very sparingly represented.

DEXAMINIDÆ.

Dexamine thea, Boeck.

This comparatively small species was captured in Bay of Nigg, near Aberdeen, and also near Muckle Ferry, Dornoch Firth. The gathering from Muckle Ferry was collected in May, and that from Bay of Nigg in July, 1900.

Tritæta gibbosa (Bate).

This curious little species was dredged by the "Garland" in Loch Etive, near Abbot's Island, in 9 fathoms, on March 30th, 1900.

Guernia coalita (Norman).

This curious little species was obtained in a gathering collected by the "St. Andrew" about fifty miles south-south-east of Fair Island, in about 85 fathoms, on October 16th, 1900. The species was described by the Rev. A. M. Norman in 1868 from specimens collected in the surface-net at Lerwick, Shetland, by the late Dr. Robertson of Millport.* The same species has been obtained at considerable depths in the Firth of Forth,† in the Firth of Clyde,‡ and in the Irish Sea,** and it is interesting to note that, though its distribution is thus apparently extensive, it is one of the few British species of Amphipoda that have not yet been recorded from Norway.

MELPHIDIPPIDÆ.

Melphidippella macera (Norman).

Melphidippa and *Melphidippella* have been removed by Stebbing from the *Gammaridæ* into a new family, *Melphidippidæ*. The brick-red colour of the *Melphidippella* makes it a fairly conspicuous object even in a crowded gathering. The species was found in the gatherings collected eastward of Fair Island, and also off Aberdeen in October, 1900, but although of frequent occurrence in the gatherings from both places, scarcely a single specimen was undamaged, owing to the appendages being so brittle.

GAMMARIDÆ.

Amathilla homari (Fabricius).

A moderately large female specimen was found in the stomach of a Cod captured in the Bay of Nigg in June, 1900; young specimens were also taken in the Bay in July by means of a tow-net worked from a rowing-boat.

Gammarus duebeni, Lilljeborg.

This *Gammarus* is moderately frequent in brackish-water pools at the mouth of the River Don near Aberdeen.

* *Ann. and Mag. Nat. Hist.*, (4), vol. ii., p. 418 (1868); *Brit. Assoc. Rept.* for 1868 (pub. 1869), p. 280.

† *Eighth Annual Report Fishery Board for Scotland*, Part III., p. 326.

‡ *Seventeenth Ann. Report Fishery Board for Scotland*, Part III., p. 265 (1899).

** A. O. Walker, Revision of the Amphipoda of the L.M.B.C. District (*Trans. L'pool. Biol. Soc.*, vol. ix. (1895), p. 307.

Mœra othonis (M.-Edw.).

This species was obtained in a gathering of material dredged by the "Garland" in 72 fathoms in the Sound of Mull, March 31st, and in another gathering collected off Aberdeen in 45 fathoms, November 7th 1900.

Mœra lovéni (Bruzelius). (Pl. XVIII., figs 27 and 28.)

A damaged specimen of this species was obtained in a gathering collected about fifty miles south-east of Fair Island in about 60 to 65 fathoms, October 19th, 1900. Figures 27 and 28 represent the first and second gnathopods of this specimen.

Cheirocrates assimilis (Lillejeborg).

One or two specimens of this species were dredged in 72 fathoms in the Sound of Mull on March 31st, and in 40 to 49 fathoms, off Aberdeen, on October 23rd, 1900.

LILLJEBORGIIDÆ.*

Lilljeborgia kinahani (Bate).

One or two specimens of this species occurred in the same gathering with the *Cheirocrates* dredged in the Sound of Mull on March 31st, 1900.

PHOTIDÆ.

Photis longicaudata (Bate).

This species was collected about fifty miles south-south-east of Fair Island in October, and off Aberdeen in 45 fathoms in November, 1900.

ISCHYROCERIDÆ.†

Ischyrocerus anguipes, Kröyer. (Pl. XVIII., fig. 29.)

This species was obtained in a tow-net gathering collected in the Bay of Nigg, Aberdeen, on July 17th, by Mr. Williamson, while carrying out some investigations in the Bay by means of a rowing-boat. There does not appear to be any previous authentic records of *Ischyrocerus anguipes* for Britain. Figure 29, Pl. XVIII., represents one of the second gnathopods of our specimen, which appears to be an adult male. This specimen though somewhat smaller than those from higher latitudes, is in other respects quite characteristic; the Rev. A. M. Norman has examined the specimen and considers it to be a true *Ischyrocerus anguipes*.

Ischyrocerus minutus, Lilljeborg.

This species occurred in some material collected by the "Garland" at Muckle Ferry, Dornoch Firth, on May 19th, and it was also obtained in the same gathering from Bay of Nigg in which the *Ischyrocerus anguipes* occurred.

* See Revision of Amphipoda, by Rev. T. R. R. Stebbing, *Ann. and Mag. Nat. Hist* (7), vol. iv., p. 211 (1899).

† Stebbing, *op. cit.*, p. 211.

Jassa falcata (Montagu). (= *Podocerus falcatus* (Mont.), in Sars' Crustacea of Norway, vol. iii., p. 594, 1895).*

A fine male specimen of *Jassa falcata* [*Podocerus falcatus* (Mont.) of Sars' *Crustacea of Norway*, vol. iii., p. 594] was found in the stomach of a Long-spined Cottus, *Cottus scorpius*, captured in the Bay of Nigg on June 6th. Another specimen, scarcely mature, was found adhering to a second *Cottus scorpius* captured in the Bay in July, while several others were obtained in a tow-net gathering collected also in the Bay of Nigg in July.

Jassa pusilla (G. O. Sars).

This was obtained in a tow-net gathering, collected by rowing-boat, in Bay of Nigg, in July; and in another collected by the "Garland" in 45 fathoms, off Aberdeen, November 11th, 1900.

†*Microjassa cumbrensis* (Stebbing and Robertson).

Dredged in 72 fathoms in the Sound of Mull, on March 31st, 1900, and forwarded to the Laboratory at Bay of Nigg, from the "Garland."

†*Parajassa pelagica* (Leach). [*Janassa capillata* (Rathke), G. O. Sars.]

The densely setose character of both pairs of antennæ, gives to this species a striking appearance. A few specimens were obtained by Mr. Williamson in some tow-net gatherings which he collected in the Bay of Nigg in July and the beginning of August (1900). *Parajassa* was also obtained in the stomach of a Pollack caught in the salmon-nets in the Bay of Nigg on the 4th of May previous.

It may be noted in passing that Mr. A. O. Walker, in the Fourteenth Annual Report of the Liverpool Marine Biology Committee (*Trans. L.-pool. Biol. Soc.* (1900), p. 16), objects to the use of the name *Parajassa* for a genus of Amphipods, and states that he fails to see why *Jassa* of Leach, 1815, should be displaced by a genus of fossil fish founded in 1839. But the restoration of *Jassa* for those amphipods for which *Parajassa* has been proposed can only hold good if it has been proved that they do not after all differ generically from such other forms as *Jassa* (*Podocerus*) *falcata* (Mont.). If, on the other hand, it is found that those Amphipods really differ generically from *Jassa falcata*, and if, for the reason stated, the name *Parajassa* may not be used for them, it seems to me that some other name than *Jassa* will require to be substituted, as it can hardly be utilised for two genera, even though they belong to the Amphipoda and are closely allied to each other.

Erichthonius hunteri (Bate).

Specimens of *Erichthonius hunteri* have on one or two occasions been observed in gatherings collected off Aberdeen, but usually in moderately deep water. It occurred in a gathering collected by the "Garland" in 40 to 49 fathoms on October 23rd, and in another collected in 45 fathoms on November 7th (1900). There appear to be few authentic British records of this species.

* Stebbing, Ann. and Mag. Nat. Hist. (7), vol. iii., p. 237 (March 1899); *see* also A. O. Walker, *op. cit.*, vol. iii., p. 294 (May 1899).

†For changes in generic names see Stebbing, Revision of Amphipoda, *Ann. and Mag. Nat. Hist.*, (7), vol. iii., p. 240 (1899).

COROPHIIDÆ.

Siphonoecetes colletti, Boeck.

This species was obtained in a gathering collected about fifty miles south-south-east of Fair Island on October 16th, 1900. British specimens of this species have sometimes been recorded as *Siphonoecetes typicus*, Kröyer; but it seems that Kröyer's *S. typicus* is a truly Arctic species.

Corophium grossipes (L.).

A few specimens of this *Corophium* occurred in a surface tow-net gathering collected by the "Garland" off the Ferry Slip at Invergordon, Cromarty Firth, on June 16th, 1900. The usual habitat of this species is in brackish-water pools which have a soft muddy bottom, and it occurs in pools of this description at the mouth of the River Alness, a few miles to the west of Invergordon; these pools are occasionally covered by the sea at high water. In such pools the *Corophium* may frequently be observed rising quickly out of the mud, and after swimming a short distance drop down and as quickly disappear, being apparently unable to swim continuously for any lengthened period. The presence of the specimens in the surface tow-net, therefore, may probably be due to their having been carried down by the ebbing tide while clinging to some floating rubbish; that this explanation of their presence in the surface tow-net is probably the correct one is borne out by the fact that several beetles and other insects were also observed in the same gathering.

Corophium affine, Bruzelius.

Though I only record this species for the Moray Firth now, the one or two specimens obtained were dredged in 1895 on July 25th. The material in which they were obtained was dredged from 100 fathoms a few miles to the northward of Rosehearty. The marked difference in the form of the third pair of uropods, together with the slender antennules, makes this species easily distinguished from the other members of the genus.

Unciola planipes, Norman.

This species was dredged by the "Garland" off Aberdeen in 45 fathoms, November 7th, 1900. *Unciola planipes* was described from specimens which Dr. Norman dredged in deep water off the Northumberland coast.*

DULICHIIDÆ.

Lætmatophilus tuberculatus, Bruzelius.

This rare species was represented by a damaged specimen in a gathering collected by the steam trawler "St. Andrew" about fifty miles south-east of Fair Island, in about 60 to 65 fathoms, on October 19th, 1900. *Lætmatophilus armatus* (Norm.) was obtained by Rev. A. M. Norman in material dredged from 100 to 110 fathoms, N. by W. of Burrafirth Lighthouse in 1867, and I at first thought that the specimen obtained off Fair Island might belong to the same species, but a careful examination showed that it was the *Lætmatophilus tuberculatus* of Bruzelius. G. O. Sars describes this species as rather abundant in several localities off the west coast of Norway in depths of 20 to 50 fathoms. *Lætmatophilus*

Nat. Hist. Trans. of Northumb. and Durham, vol. i. (1865), p. 14, Pl. VII., figs. 9–13.

has been recorded for the British Islands by Spence Bate under the name of *Cyrtophium tuberculatum.*

Dulichia porrecta (Bate).

This easily distinguished species was obtained in a gathering collected by the "Garland" at Muckle Ferry, Dornoch Firth, May 19th, and also in a gathering collected by the steam trawler "St. Andrew" fifty miles south-south-east of Fair Island, October 16th, 1900.

Dulichia monacantha, Metzger.

This *Dulichia* was recorded for the first time as a British species in the "Annals of Scottish Natural History" for January, 1898, p. 55, and afterwards in the Sixteenth Annual Report of the Fishery Board for Scotland (1898), Part III., p. 277. The specimens, which were from the Clyde, comprised a male possessing the well-developed horn-like processes of the first coxal plates and one or two doubtful females. During the recent investigations carried out in the North Sea by the steam trawler "St. Andrew" numbers of small fish were captured, some of which were handed over to me for examination in order to ascertain what they had been feeding on; among these were a number of Haddocks about four to five inches in length, captured about sixty-five miles south-east by east of Sumburgh Head, Shetland, on September 4th, and it was interesting to find, in nearly all the stomachs examined, specimens of *Dulichia monacantha*; in several instances the stomachs of the young Haddocks were crowded with nothing else; both males and females of the Amphipod occurred, but the males appeared to be the most numerous, and unfortunately almost all of them had been more or less damaged by the teeth of the fish. Fragments of *Dulichia porrecta* were also observed, and also of *Aceros phyllonyx*, and a few other forms, but these appeared to be rare. *Dulichia monacantha* occurred also in a bottom tow-net gathering collected about fifty miles south-east of Fair Island on October 19th (1900).

CAPRELLIDÆ.

Phtisica marina, Slabber.

This species was not uncommon in gatherings collected to the east of Fair Island, October 19th, 1900.

Protella phasma (Mont.).

This was occasionally obtained in gatherings collected off Aberdeen in October and November last by the Fishery steamer "Garland."

Caprella (?) *septentrionalis*, Kröyer.

The *Caprellas* which I have ascribed to Kröyer's *C. septentrionalis* were on several occasions obtained in the stomachs of Pollack, *Gadus pollachius*, captured in the salmon-fishers' nets in the Bay of Nigg, but rarely in the stomach of the Cod; they were observed in the stomachs of these fishes during April and May last year, and I have no notes of their occurrence during any of the other months. An immense number of *Caprellas* were obtained in the stomach of a half-grown Pollack captured on April 20th; males and females appeared to be equally numerous, the stomach was packed with them. Among other things observed in this stomach were one or two *Idotea pelagica* and fragments of two *Amathilla homari.*

None of these Bay of Nigg *Caprellas*—which I think belong all to the one species—reach the dimensions given by G. O. Sars for *Caprella septentrionalis*; the largest males obtained in the stomachs of the Pollacks measured from 20 to about 22 millimeters in length, while the adult females were only about half that size; the measurements given by Sars, on the other hand, are "length of adult female reaching 19 mm., of male 27 mm." Some of the Bay of Nigg males and the greater proportion of the females are rather more prominently tuberculated than they are shown to be in Professor Sars's description and figures, but with these exceptions they appear to be identical with *Caprella septentrionalis*, Kröyer. The second gnathopods of the male are large and powerful, they are articulated slightly behind the middle of the second segment of the mesosome, and the propodos is armed with a stout claw; the distal portion of the claw is strongly curved, and the inner margin near the base is furnished with a shallow but distinct tooth; the palm of the propodos has a dense fringe of short, slender bristles. The surface of the body is thickly besprinkled with minute points, and in certain positions, when viewed with an inch objective, the bases of these points look like hyaline circular depressions, and it is only when the light strikes across the surface of the body that the projecting points can be seen.

One thing which appears to militate against the Bay of Nigg *Caprellas* being really the *C. septentrionalis* of Kröyer is that the distribution of that species seems to be arctic or sub-arctic rather than north temperate; but the same may be said of *Ischyrocerus anguipes*, Kröyer, an undoubted example of which has been found in the Bay of Nigg; of *Anonyx nugax* (Phipps), which has been obtained near the May Island, Firth of Forth, and in the Cromarty Firth; of *Byblis gaimardi* (Kröyer), also obtained off the May Island, as well as of other northern forms which have been found on various parts of the Scottish coasts. If the above objection shows anything, it is rather that our knowledge of distribution is not yet complete, and that, as the investigation of our seas is proceeded with, it is highly probable that other forms, whose distribution was wont to be considered more northern or more southern, will yet turn up to swell the list of the Scottish marine fauna.*

An interesting fact in connection with the Bay of Nigg *Caprellas* is that such a large number of them should be found in the stomach of a single fish; it seems as if the Pollack had been able to discriminate between the various organisms which happened to be within its reach and that it had selected the *Caprellas* in preference to the others. But, as is well known, *Caprella* consists of an elongated slender body, to which are articulated still more slender appendages; it can therefore, one would think, afford little nourishment to a hungry fish; and why the fish should select this creature in preference to more succulent morsels, such as some of the common Gammaridæ, the smaller Eupagurida, and others, is somewhat curious.

Sub-order ISOPODA

TANAIDÆ.

Typhlotanais brevicornis (Lilljeborg).

This species was obtained in a gathering collected by the steam trawler "St. Andrew," on November 3rd, about thirteen or fourteen miles north-east from Buckie, in 50 to 55 fathoms. This is the first time that a

* It is also to be noted that *Caprella septentrionalis*, Kröyer, has also been recorded from the Clyde on the authority of the late Dr. Robertson of Millport.

species of *Typhlotanais* has been observed in the British seas, and that this should be so is the more interesting from the fact that no fewer than nine species are known to occur off the coast of Norway, but the majority of them are small, and limited in their distribution to moderately deep water, and this may account to some extent for their having escaped notice hitherto. The length of *Typhlotanais brevicornis* is only about 1½ mm.

Paratanais batei, G. O. Sars.

This species was collected by the "Garland" in Loch Etive in 9 fathoms, off Abbot's Island, on March 30th. This is a new station for *Paratanais batei* on the West Coast.

Leptognathia breviremis (Lilljeborg).

This was collected by the "Garland" off Aberdeen in 45 fathoms on November 11th last year.

Leptognathia brevimana (Lilljeborg).

L. brevimana is a more slender species than the last, and is readily distinguished by the structure of the uropods, the outer branches of which appear to be but spiniform prolongations of the outer angles of the basal joints. I have one or two records of this species for the Moray Firth, where it has been taken by the "Garland," as well as off Aberdeen, where it was collected in 45 fathoms along with the next form on November 11th.

Leptognathia (?) *longiremis* (Lillj.), var. (Pl. XVIII., figs. 30–38.)

In the female of this *Leptognathia* the body is elongated and narrow, being about seven times longer than broad (fig. 30). The terminal segment of the metasome has no apparent denticle on its lateral margins as in *Leptognathia longiremis* (Lilleborg). The antennules (superior antennæ) are moderately elongate, being equal to about one-seventh of the length of the body; in the majority of the specimens examined the antennules were four-jointed (fig. 32), but, on the other hand, a number were observed which had the antennules distinctly five-jointed (fig. 33), though in other respects they appeared to be identical with those possessing the four-jointed antennules. In the four-jointed antennules the first joint is scarcely so long as the combined lengths of the next three joints, the second and the last joints are nearly equal, while the third is only equal to about half the length of the preceding joint. In the five-jointed antennules the first joint is about twice as long as the second; the second, in its turn, is about the length of the third joint; the fourth joint is very small, while the end-joint is nearly as long as the entire length of the third and fourth.

The antennæ (inferior antennæ) are very similar to those of *Leptognathia longiremis* (Lillejborg), (fig. 35).

The chelipeds (fig. 36) and the walking legs are very similar to the same appendages in the female *Leptognathia longiremis*.

The inner branches of the uropods, which are elongated, consist of two sub-equal joints, but the outer branches, which are also two-jointed, are scarcely as long as the first joint of the inner branches (fig. 38). Length of the female scarcely 2·5 mm.

In the male the body is considerably shorter and broader than that of the female (fig. 31). The antennules are proportionally longer than those of the female; the first two joints of the peduncle are dilated, but the

second is only about half as long as the first one; the penultimate joint of the flagellum is distinctly longer than either the preceding or the following joints (fig. 34).

The chelipeds of the male (fig. 37) are nearly as robust as those of the female; they are each provided with a transverse row of slender spines similar to those on the hands of the male chelipeds in *Leptognathia longiremis*.

Habitat.—In the deep water off Aberdeen and in the Moray Firth; not very rare.

Remarks.—This *Leptognathia* is, in its general appearance, as well as in some of its structural details, not unlike *Leptognathia longiremis* (Lilljeborg), but it appears to be a smaller form, and it differs in the terminal segment of the metasome, having no apparent denticles on its lateral margins.

In the male there are one or two marked differences, and especially in the structure of the antennules. In the antennules of the male of *Leptognathia longiremis* the last two joints of the flagellum are about equal to each other in length, and each of them is much longer than either of the two preceding joints, whereas in the form under consideration the end-joint is not much more than half the length of the penultimate one, and its length does not greatly exceed that of the antepenultimate joint. Moreover, the inner branches of the uropods appear to be only two-jointed, whereas in the male of *Leptognathia longiremis* they appear from the drawings of Prof. G. O. Sars to be three-jointed.* Male specimens appear to be very scarce.

Tanaopsis laticaudata, G. O. Sars.

This Isopod, which I have recorded from the Clyde and one or two other places, has had its known distribution still further extended during the past year, having been obtained by the "Garland" in Loch Etive, and also in Loch Eil (off the head of Loch Linnhe). The species was collected in Loch Etive near Abbot's Island in 9 fathoms on March 30th, and in Loch Eil in 30 fathoms on April 3rd, 1900.

Pseudotanais forcipatus (Lilljeborg).

This species occurred along with the *Typhlotanais brevicornis* previously recorded in the gathering collected in 50 to 55 fathoms, north-east of Buckie, on November 3rd. *Pseudotanais forcipatus* is not very rare in the Moray Firth, especially in comparatively shallow water, as at Guillam Bank, in 8 to 10 fathoms.

CIROLANIDÆ.

Cirolana borealis, Lilljeborg.

A specimen of *Cirolana borealis* occurred in a gathering collected by the "St. Andrew" to the eastward of Fair Island on October 12th. The same species has also been obtained by the "Garland" off the coast of Caithness and in the Clyde. Rev. A. M. Norman records it as not uncommon on the "Haddock Ground" near Whalsey Skerries, and in St. Magnus Bay, Shetland.†

* "Crustacea of Norway," vol. ii. (Isopoda), Plate XII.

† *Brit. Assoc. Report*, 1869, p. 288.

Eurydice pulchra, Leach.

Eurydice was taken with the surface tow-net by the "St. Andrew" on October 15th while at anchor in Lerwick Bay, Shetland; only one or two specimens were observed. Rev. A. M. Norman has recorded the same species from St. Magnus Bay.

IDOTHEIDÆ.

Idothea pelagica, Leach.

Specimens of this small Isopod were frequently observed in the stomachs of Pollacks and Flounders, *Pleuronectes flesus*, captured in the salmon-nets in the Bay of Nigg during the past spring and summer (1900); sometimes they occurred in considerable numbers and in a fairly perfect condition. The same Isopod was also occasionally observed in tow-net gatherings collected in the Bay; the specimens observed comprised both males and females—some of the latter with ova.

Idothea emarginata (Fabricius).

This *Idothea* was also of frequent occurrence in the stomachs of fishes captured in the salmon-nets in the Bay of Nigg; it was also obtained in some of the gatherings collected by the "Garland" off Aberdeen in November last.

Idothea linearis (L.).

This species was obtained in the stomachs of Pollacks captured in the salmon-nets in the Bay of Nigg—especially in the stomachs of those captured in April. In one or two of the stomachs of Pollacks captured on the 2nd of the month *Idothea baltica*, *pelagica*, *emarginata*, and *linearis* were observed, together with *Paratylus swammerdami*, *Amathilla homari*, *Parajassa pelagica*, *Caprella septentrionalis*, and a post-larval Eel, "*Leptocephalus*."

ARCTURIDÆ.

Astacilla intermedia (Goodsir). (=*Astacilla affinis*, G. O. Sars.)*

Males and females of this Isopod were obtained in three separate gatherings of Crustacea collected by the "St. Andrew" about fifty miles south-east of Fair Island, in about 65 fathoms, on October 19th, but only a few specimens altogether were observed. Another species—*Astacilla longicornis* (Sowerby)—is described by Rev. A. M. Norman as common in the Shetland Islands.† No specimens, however, were observed in the gatherings collected by the "St. Andrew," but a few were obtained in one of the deep-water gatherings collected by the "Garland" off Aberdeen on October 25th; this gathering was from 60 fathoms. It also occurred in a gathering from 45 fathoms collected on November 11th.

Arcturella dilatata, G. O. Sars.

This somewhat rare species was obtained in one of the gatherings collected to the east of the Fair Island on October 12th. The only other

* Sars, "An Account of the Crustacea of Norway," vol. ii., Parts v. and vi. (1897), p. 90, Pl. XXXVII., fig. 2. The Rev. A. M. Norman considers that *A. affinis*, G. O. Sars, is identical with Goodsir's *A. intermedia*.

† *Brit. Assoc. Rept.*, 1869, p. 289.

British record for *Arcturella* that I at present know of is that of the late Dr. Robertson of Millport for the Clyde; he dredged it off Blackwaterfoot, Arran, Firth of Clyde, in 20 fathoms.*

MUNNIDÆ.

Paramunna bilobata, G. O. Sars.

This small species was obtained in a gathering collected south-east of Fair Island on October 19th, in about 65 fathoms. This species, though small, is quite distinct, and appears to be extensively distributed around the Scottish coasts. It is one of the species obtained in the stomachs of small Haddocks captured sixty-five miles south-east by east of Sumburgh Head on September 4th, 1900.

Pleurogonium inerme, G. O. Sars.

P. inerme was dredged off Aberdeen by the "Garland" in 45 fathoms on November 7th, 1900.

Pleurogonium spinosissimum, G. O. Sars.

One or two specimens of this distinct species were dredged by the "Garland" in the Sound of Mull in 72 fathoms on March 31st, 1900.

DESMOSOMIDÆ.

Macrostylis spinifera, G. O. Sars. (Pl. XVIII., fig. 39.)

A single damaged specimen, which is represented by figure 39 on Plate XVIII., was obtained amongst a small quantity of sand collected by the "St. Andrew" about fifty miles south-east of Fair Island on October 19th, 1900; nearly all the appendages of the specimen were broken off—even the styliform uropods were damaged. The species was obtained in about 65 fathoms, and is an addition to the British fauna. Prof. Sars mentions that it occurs in a few Norwegian localities, from the Lofoten Islands to Christiania Fjord, and that the *Vana longiremis* of Meinert from the Kattegat belongs also to this species.

Echinopleura aculeata, G. O. Sars. (Pl. XVIII., fig. 40.)

This Isopod was obtained in the same gathering with the last, and is also an addition to the British Crustacean fauna. Two specimens were observed, and both were damaged; it is the best specimen of the two which is represented by figure 40 on Plate XVIII. The Norwegian distribution of *Echinopleura* appears to be similar to that of *Macrostylis*, but Prof. Sars remarks that "it seems everywhere to be very rare." The form of the body and the strongly-serrated margins of the segments impart to *Echinopleura* quite a distinctive character.

BOPYRIDÆ.

Phryxus abdominalis (Kröyer).

This Epicarid was moderately frequent on the specimens of *Spirontocaris securifrons* captured by the "Garland" off Aberdeen in October and November last. What appears to be the same species of *Phryxus* was

* "Amphipoda and Isopoda of the Firth of Clyde," Part ii., p. 28 (1892), separate copy.

also obtained on *Spirontocaris pusiola*, collected by the "Garland" in 45 fathoms off Aberdeen, November 7th.

Professor G. O. Sars states that *Phryxus abdominalis*, which is the commonest of the Norwegian Bopyrids, is found infesting no fewer than nine different Carides:—*Spirontocaris gaimardi, polaris, pusiola, turgida, spinus*, and *securifrons*, and *Pandalus montagui, borealis*, and *propinquus*, and probably one or two others.* On the other hand, M. Bonnier, who, along with Professor Giard, has devoted a long time to the study of these crustaceans, considers that the identity of the Bopyrids from all these different species of the Caridea with the *Phryxus abdominalis* of Kröyer, which is found on *Spirontocaris gaimardi*, M.-Edw., is at least open to doubt.† I may say, however, that, so far as I have been able to make them out, the species I have recorded above agree very well with the description and figures of *Phryxus abdominalis*, Kröyer, given by Professor Sars in the work referred to.

Sub-Order SYMPODA, Stebbing, 1900 (CUMACEA, Auctorum).

Rev. T. R. R. Stebbing has shown that *Cuma*, so familiar as the name of a genus of Crustaceans, had long before been used as the name of a Molluscan genus, and further, that it was necessary that the sub-ordinal name "Cumacea," which had been derived from *Cuma* and therefore could not stand, must be replaced by some other, and the name he proposes as a substitute is "Sympoda." ‡

Fam. Bodotriidæ, Stebbing

The generic name *Cuma* being set aside as preoccupied, leaves room for the restoration of Goodsir's *Bodotria*, and as *Bodotria* is the typical and the oldest genus in the family with which it is associated, it necessarily forms the basis of the family name.

Genus *Bodotria*, Goodsir (1843).

Bodotria arenosa, Goodsir (*Cuma scorpioides*, G. O. Sars), was obtained in a gathering collected by the steam trawler "St. Andrew," about fifty miles south-south-east of Fair Island on October 16th; in this species the inner ramus of the uropods is composed of a single piece. *Bodotria scorpioides* (Mont.) (= *Cuma edwardsii*, Goodsir) has been obtained in gatherings collected during the past year in the Dornoch Firth, and off Aberdeen; in this species, which appears to be more common than the previous one, the inner ramus of the uropods is distinctly biarticulated. *Bodotria pulchella* (G. O. Sars) occurred in gatherings collected by the "Garland" off Aberdeen in 36 to 49 fathoms in October, and in November in 45 fathoms.

Genus *Iphinoë*, Spence Bate (1856).

Iphinoë serrata, Norman, was moderately frequent in one or two of the gatherings collected to the south-eastward of Fair Island in October last.

* G. O. Sars, "An Account of the Crustacea of Norway," vol. ii. (Isopoda), p. 217 (1896–99).

† Jules Bonnier, "Contribution a l'étude des Epicarides Les Bopyridæ," *Publications de la Station Zool. de Wimereux*, viii., p. 381 (1900).

‡ Stebbing: On Crustacea brought by Dr. Willey from the South Seas. *A. Willey's Zoological Results* part v., p. 609 (Dec. 1900).

Fam. LAMPROPIDÆ.

Lampropa fasciata, G. O. Sars.

This species was frequent in some tow-net gatherings collected by the "Garland" while at anchor off Ardjachie Point in the Dornoch Firth, between 8.45 p.m. on the 16th and 5 a.m. on the 17th of May, 1900.

Hemilamprops rosea (Norman).

This was moderately frequent in tow-net gatherings collected off Fair Island in October, and it was also observed occasionally in the stomachs of small Haddocks captured about 65 miles south-east by east of Sumburgh Head in September. It was the only species belonging to the Lampropidæ observed in the gatherings.

Fam. LEUCONIDÆ.

Leucon nasicus (Kröyer).

L. nasicus was also one of the more common forms in the gatherings collected off Fair Island by the steam trawler "St. Andrew" in October last.

Eudorellopsis deformis (Kröyer).

This curious small species was occasionally observed in company with *Eudorella marginata* (Kröyer) in the gatherings collected off Fair Island, but neither the one nor the other was very frequent.

Fam. DIASTYLIDÆ.

Diastylis lucifera (Kröyer) and *Diastylus rostrata* (Goodsir) have both been obtained in tow-net gatherings collected in the Bay of Nigg, near Aberdeen, by Mr. H. C. Williamson in July, 1900, while engaged in some special researches in the Bay.

Diastylis tumida (Lilljeborg).

A single specimen of this somewhat rare species was obtained in some material dredged by the "Garland" in 130 fathoms a few miles to the north of Rosehearty, Moray Firth.

Diastylis cornutus (Boeck).

Several specimens of this well-marked species occurred in tow-net gatherings collected in deep water about fifty miles south-eastward of Fair Island on the 12th and 19th October. *Diastylis cornutus* was obtained for the first time as a British species by the Rev. A. M. Norman, who dredged it in Shetland in 1863. Most of the specimens collected off Fair Island were more or less damaged.

Diastylopsis resima (Kröyer).

This species also occurred in the gatherings collected off Fair Island along with *Diastylis cornutus*; male and female specimens of *Diastylopsis resima* were observed, but though the species was moderately frequent, few of the specimens were undamaged, and nearly all were more or less

covered with mud. This is the first time that *Diastylopsis resima* has been observed in Scottish waters. *Diastyloides biplicata*, G. O. Sars, was also frequent in the same gatherings.

Leptostylis villosa, G. O. Sars. (Pl. XVIII., fig. 41.)

This species has been added to the British fauna during the past year. The first specimens were obtained in the Firth of Clyde in 1896 in a tow-net gathering from 40 fathoms collected by the "Garland" between Arran and the coast of Ayrshire. It has also been observed in a tow-net gathering collected fifty miles south-east of Fair Island, in about 60 to 65 fathoms, on October 19, by the steam trawler "St. Andrew." *Leptostylis villosa* may be distinguished from its confrères by the peculiar form of the marginal serration of the carapace; figure 41, Plate XVIII., represents a small portion of the margin of the carapace, and shows the peculiar form of the serration.

PSEUDOCUMIDÆ.

Pseudocuma similis, G. O. Sars.

This species has also been lately added to the British fauna from the Firth of Clyde. It was obtained in a gathering collected by the "Garland" in moderately deep water near the mouth of the estuary in December, 1899. *Pseudocuma similis* has also been obtained in gatherings collected by the steam trawler "St. Andrew" off Fair Island in about 80 to 85 fathoms on October 16th, and by the "Garland" off Aberdeen in 42 to 45 fathoms on November 7th and 12th, 1900. Although it is not very difficult to recognise this *Pseudocuma* after the observer has become familiar with its peculiarities, it nevertheless so closely resembles the more common *Pseudocuma cercaria* (v. Beneden), with which it is frequently associated, that it may be readily passed over as belonging to that species. *Pseudocuma similis* has also recently been recorded from the Irish Sea,* which seems to indicate that the distribution of this species in British waters may be fairly extensive.

Petalosarsia declivis, (G. O. Sars).

Petalosarsia was obtained in at least three different gatherings collected by the "Garland" off Aberdeen in October and November last year; it occurred in a gathering from 36 to 49 fathoms collected on October 23rd, and in one from 60 fathoms collected on the 25th, and it also occurred in a gathering collected on November 7th from 45 fathoms, The same species was also observed in one of the gatherings collected by the steam trawler "St. Andrew" off Fair Island on October 16th.

NANNASTACIDÆ.

Cumella pygmæa, G. O. Sars.

This small species occurred in the gathering collected by the "Garland" in 45 fathoms off Aberdeen on November 7th. It was also collected in Aberdeen Bay by Mr. H. C. Williamson on August the 9th. The species is very small and easily missed.

* A. Scott, in *Lancashire Sea Fisheries Report* for 1900 (March 1901).

Nannastacus unguiculata, Spence Bate.

Male and female specimens of this curious species were captured by the steam trawler "St. Andrew" in Lerwick Bay, Shetland, by means of a surface tow-net put overboard for four hours while the vessel was at anchor. A single male specimen of *Vaunthompsonia cristata* was also obtained in this gathering. *Nannastacus unguiculata* was taken at Shetland in 1863 by the Rev. A. M. Norman; it was also taken in Lerwick Bay in 1867 by David Robertson by means of a surface tow-net,* and in connection with this it is interesting to note, from the point of view of the distribution of the species, that though *Vaunthompsonia cristata* and *Nannastacus unguiculata* are both members of the Shetland marine fauna, and the latter especially not uncommon, yet Professor G. O. Sars in his work on the Norwegian species belonging to the Sympoda, recently published, does not include either of the forms named.

CAMPYLASPIDÆ.

Campylaspis rubicunda (Lilljeborg).

This species was obtained in gatherings collected by the "St. Andrew" off Fair Island on the 12th, 16th, and 19th of October at various depths from 60 to over 80 fathoms.

Campylaspis costata, G. O. Sars.

This species was obtained in the same gatherings with the last, and was, if anything, more frequent. It also occurred in a gathering from Loch Aber (upper end of Loch Linnhe) collected by the "Garland" in 82 fathoms on April 2nd.

Sub-order SCHIZOPODA.

MYSIDÆ.

Mysidopsis didelphys (Norman).

This Schizopod has been obtained during the past year by the "Garland" off Aberdeen, and by the "St. Andrew" off the Fair Island. It was collected off Fair Island in 60 to 70 fathoms on the 19th of October, and off Aberdeen in 60 fathoms on the 25th of the same month. The Rev. A. M. Norman obtained it in 40 to 50 fathoms, five to eight miles east of Balta, Shetland.†

Heteromysis formosa, S. I. Smith.

Hitherto the Firth of Forth is the only Scottish locality whence this Schizopod has been recorded.‡ It is one of the many species which have been added to the Scottish marine fauna as one of the results of the investigations carried on under the direction and by the encouragement of the Fishery Board for Scotland. I have now to record *Heteromysis formosa* for the first time for Loch Fyne and the Moray Firth. It occurred with some other rare things in material dredged by the "Garland" at Tarbert Bank, Lower Loch Fyne, in about 20 fathoms, on

* Norman. Last Report on Dredging among the Shetland Islands; *Rept. Brit. Assoc.* for 1868, p. 270. (Pub. 1869).

† Norman, *op. cit.*, p. 267.

‡ *Seventh Annual Report of the Fishery Board for Scotland*, part iii., p. 323.

December 22nd, 1899, and again on the 28th of March, 1900; only three specimens altogether were observed, and two of them were slightly damaged. The species was obtained in the Moray Firth district at Station IV. (off Little Ferry), in 7 to 10 fathoms, on April 10th, 1900. This gathering, which was collected by the "Garland," yielded only one or two specimens of the Schizopod.

Erythrops serrata, G. O. Sars.

This species has been obtained during the past year in gatherings collected south-eastward of Fair Island, on the 16th and 19th October, by the "St. Andrew," at a depth of 60 to 80 fathoms. It was also collected by the "Garland" in 60 fathoms, off Aberdeen, on October 25th. *Erythrops serrata*, which is also one of the Schizopods obtained by the Rev. A. M. Norman while dredging among the Shetland Islands,* does not appear to be a rare species in the North Sea.

Macropsis slabberi (Van Beneden).

Though *Macropsis* is frequent enough on some parts of the East Coast of Scotland, and was recorded for the Firth of Forth by Dr. Henderson as long ago as 1884, I have only recently been able to find traces of it on the West Coast. I obtained an undoubted specimen of this species in the stomach of a young Herring—one of several which Dr. Fulton had received from Annan, Solway Firth, and which he had kindly handed over to me for examination. The fact that *Macropsis* was found in the stomach of this Herring from the Solway is fairly satisfactory evidence that the species exists somewhere near the place where the fish was captured. The Herring were captured on July 30th, 1900. *Macropsis slabberi* has also been obtained in a tow-net gathering collected by the "Garland" in the Cromarty Firth in 7 to 8 fathoms on the 30th of November last.

Leptomysis gracilis, G. O. Sars.

This species occurred in one of the bottom gatherings collected south-east of Fair Island by the "St. Andrew" on October 19th; and it is one of the Schizopods recorded for Shetland by Rev. A. M. Norman in 1869.

Gastrosaccus spinifer (Goes).

Young specimens of *Gastrosaccus spinifer* were moderately frequent in one or two of the gatherings collected by the "Garland" off Aberdeen in October and November, 1900. One of the gatherings in which this species occurred was collected in 60 fathoms, and another in 45 fathoms; adult specimens were scarce in both gatherings.

Siriella armata (M.-Edw.).

This species was obtained in a bottom tow-net gathering collected by the "Garland" in 7 to 10 fathoms at Station IV., Moray Firth (off Little Ferry), on December 6th, 1900.

* Norman, *op. cit.*, p. 270.

Sub-Order MACRURA.

CALLIANASSIDÆ.

Callianassa subterranea (Mont.).

A specimen of this Crustacean, obtained in the stomach of a common Gurnard, *Trigla gurnardus*, captured in the Moray Firth, was forwarded to the Laboratory at Bay of Nigg by Mr. F. G. Pearcey, Naturalist on board the "Garland." The specimen, which, though recognisable, was considerably decomposed, was obtained on June the 14th at Station IX. (about eleven or twelve miles north-east of Lossiemouth). *Callianassa subterranea* has been known for many years as one of the invertebrates of the Moray Firth district. The species was obtained by Thomas Edward of Banff, and it has also been obtained on several occasions by Mr. Sim of Aberdeen, but always in the stomachs of fishes captured in moderately deep water, and where the bottom appears to consist of soft mud.

Eupogebia deltura, Leach.

A specimen of *Eupogebia deltura* was found in the stomach of a Haddock 13½ inches long, captured in the Moray Firth at Station VII. (about five miles east of Tarbat Ness), in February, 1900, and forwarded to the Laboratory at Bay of Nigg by Mr. F. G. Pearcey. *Eupogebia deltura*, which is also one of the Crustaceans obtained in the Moray Firth by the late Thomas Edward of Banff, appears to have a habitat similar to that of *Callianassa*.

CRANGONIDÆ.

Pontophilus spinosus, Leach.

A few fine specimens of this species were obtained by the "Garland" in 40 to 50 fathoms, off Aberdeen, in November last year.

Cheraphilus neglectus, G. O. Sars.

A few specimens of this Crangonid were collected by Mr. H. C. Williamson in the Bay of Nigg in August last year. A fine specimen was also obtained in a gathering collected by the "Garland" in 7 to 8 fathoms at Station I., Moray Firth (between Burghead and the mouth of the River Findhorn), on December 12th. This species resembles *Egion fasciatus* (Risso), but in the first the front of the rostrum is broadly rounded, while in the other the rostrum is truncate and slightly concave at the apex.

HIPPOLYTIDÆ.

Caridion gordoni (Spence Bate).

This species was moderately frequent in a gathering collected by the "Garland" in 60 fathoms, off Aberdeen, on the 25th October last; the majority of the specimens I observed were, however, more or less immature. *Caridion* differs from the closely-allied *Hippolyte* and *Spirontocaris* by the possession of a three-jointed mandible-palp.

Spirontocaris securifrons, Norman.

This Crustacean was moderately common in some gatherings collected by the "Garland," off Aberdeen, in October and November last year.

None of the specimens examined possessed the strong tooth-like projection on the dorsal aspect of the abdomen which is so characteristic of the typical *Spirontocaris spinus* of Sowerby. Though the specimens varied greatly in size and age, it was only in one or two small specimens that there was observed any tendency towards the development of a tooth-like projection on the middle of the posterior margin of the third abdominal segment. It may be that *Spirontocaris securifrons* should only be regarded as a synonym of *Spirontocaris spinus* (Sowerby); and, with the exception of the tooth-like projection on the dorsal aspect of the abdomen alluded to, they are certainly very like each other. My use here of the name is merely to indicate that the form which was common in the gatherings collected by the "Garland" off Aberdeen is the form described by Norman as *Hippolyte securifrons*.* The depth from which specimens were obtained ranged from 32½ to 60 fathoms.

Spirontocaris pusiola (Kröyer).

One or two specimens of this small species, as well as of *Spirontocaris gaimardii* (M.-Edw.), were observed in a gathering collected by the "Garland" in about 32 fathoms, off Aberdeen, on October 12th.

Pandalidæ.

Pandalina brevirostris (Rathke).

This species was not very rare in the gatherings collected off Aberdeen by the "Garland" in October and November last. Dr. Calman has, in his paper on *Pandalus*,† described certain differences between this species and the others with which it used to be generically associated; one very obvious difference between *Pandalina*, Calman, and the described species of *Pandalus* is, that *Pandalina* has a very short, nearly straight, rostrum, not unlike that of some of the species of *Spirontocaris*, while *Pandalus* has the rostrum elongated, more or less curved, and slender towards the distal end.

Sub-order BRACHYURA.

Corystidæ.

Atelecyclus septemdentatus (Mont.).

This species was obtained in a gathering collected by the "St. Andrew" fifty miles south-east of Fair Island at a depth of about 65 fathoms on October 19th. Rev. A. M. Norman describes *Atelecyclus* as a common species among the Shetland Islands. This species was also taken by the "Garland" in 60 fathoms, off Aberdeen, on October 25th.

Portunidæ.

Portunus puber (Lin.).

Several specimens of the Velvet Crab, *Portunus puber*, were captured by Mr. H. C. Williamson in the Bay of Nigg during the month of June, 1900.

* *Brit. Assoc. Rept.*, 1861; *Trans. Tyneside Field Club* (1862), p. 267, Pl. XII., figs. 1-7.

† Calman, On the British Pandalidæ; *Ann. and Mag. Nat. Hist.*, (7), vol. iii., p. 87, Pls. I.-IV., fig. 4 (Jan., 1899).

Portunus arcuatus, Leach.

A specimen of this Crab was obtained in the stomach of a Cod captured in the salmon-nets at the Bay of Nigg on June 13th, 1900.

EXPLANATION OF THE PLATES.

PLATE XVII.

(?) *Rhincalanus gigas*, G. S. Brady.

		Diam.
Fig. 1.	Foot of fifth pair, female	× 51.
Fig. 2.	Foot of fifth pair, male, slightly immature	× 51.
Fig. 3.	Abdomen and last thoracic segment, female	× 25.
Fig. 4.	Abdomen and last thoracic segment, male	× 38.

Cyclopina longicaudata, T. Scott (sp. n.).

Fig. 5.	Female, dorsal view	× 51.
Fig. 6.	One of the female antennules	× 63.
Fig. 7.	One of the antennæ	× 63.
Fig. 8.	One of the mandibles	× 95.
Fig. 9.	One of the maxillæ	× 63.
Fig. 10.	One of the first maxillipedes	× 63.
Fig. 11.	One of the second maxillipedes	× 63.
Fig. 12.	Foot of first pair	× 63.
Fig. 13.	Foot of fourth pair	× 63.
Fig. 14.	Foot of fifth pair	× 95.

Botryllophilus (?) *ruber*, Hesse.

Fig. 15.	Female, dorsal view	× 46.
Fig. 16.	Male, dorsal view	× 72.
Fig. 17.	One of the female antennules	× 96.
Fig. 18.	One of the female antennæ	× 145.
Fig. 19.	One of the first maxillipedes, female	× 145.
Fig. 20.	One of the second maxillipedes, female	× 145.
Fig. 21.	Foot of the first pair, female	× 145.
Fig. 22.	Foot of the third pair, female	× 145.
Fig. 23.	Foot of the fourth pair, female	× 145.
Fig. 24.	One of the male antennules	× 145.
Fig. 25.	Foot of the first pair, male	× 160.
Fig. 26.	Foot of the third pair, male	× 72.
Fig. 27.	Foot of the fourth pair, male	× 160.

(?) *Enteropsis wararensis*, T. Scott (sp. n.).

Fig. 28.	Female, side view	× 61.
Fig. 29.	One of the female antennules	× 580.
Fig. 30.	One of the female antennæ	× 290.
Fig. 31.	One of the mandibles	× 580.
Fig. 32.	One of the maxillæ	× 580.
Fig. 33.	One of the maxillipedes	× 580.
Fig. 34.	Foot of the third pair	× 195.

Nicothoë astaci, Aud. and M.-Edw.

Fig. 35.	One of the female antennules	× 190.
Fig. 36.	One of the mandibles	× 380.
Fig. 37.	One of the maxillæ	× 380.
Fig. 38.	One of the first maxillipedes	× 253.
Fig. 39.	Abdomen of the female	× 80.

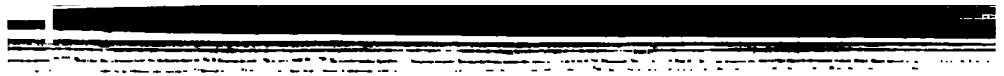


PLATE XVIII.

Eucanuella spinifera, T. Scott (gen. et sp. n.).

Fig. 1. Female, dorsal view . . . . . × 46.
Fig. 2. One of the female antennules . . . . . × 76.
Fig. 3. One of the antennæ . . . . . × 116.
Fig. 4. One of the mandibles . . . . . × 116.
Fig. 5. One of the maxillæ . . . . . × 116.
Fig. 6. One of the first maxillipedes . . . . . × 145.
Fig. 7. One of the second maxillipedes . . . . . × 145.
Fig. 8. Foot of the first pair . . . . . × 76.
Fig. 9. Foot of the fourth pair . . . . . × 63.
Fig. 10. Foot of the fifth pair . . . . . × 63.

Corycæus anglicus, Lubbock (male).

Fig. 11. Male, side view . . . . . × 61.

Cancerina confusa, T. Scott (gen. et sp. n.).

Fig. 12. Female, dorsal view . . . . . × 38.
Fig. 13. Portion of the same seen from the under-side to show the position of the maxillipedes and thoracic feet . . × 38.
Fig. 14. One of the female antennules . . . . × 145.
Fig. 15. One of the antennæ . . . . . × 290.
Fig. 16. One of the mandibles . . . . . × 290.
Fig. 17. One of the maxillæ . . . . . × 290.
Fig. 18. One of the first maxillipedes . . . . . × 193.
Fig. 19. One of the second maxillipedes . . . . . × 116.
Fig. 20. Foot of the first pair . . . . . × 116.

Nicothoë astaci, Aud. and M.-Edw.

Fig. 21. Female, dorsal view . . . . . × 11.
Fig. 22. One of the antennæ . . . . . × 380.
Fig. 23. One of the second maxillipedes . . . . × 190.
Fig. 24. Foot of the first pair . . . . . × 152.
Fig. 25. Foot of the fourth pair . . . . . × 127.
Fig. 26. Foot of the fifth pair . . . . . × 190.

Mœra lovéni (Bruzelius).

Fig. 27. One of the first gnathopods . . . . . × 7.
Fig. 28. One of the second gnathopods . . . × 5.

Ischyrocerus anguipes, Kröyer.

Fig. 29. One of the second gnathopods, male . . . . × 34.

Leptognathia (?) *longiremis* (Lillj.), var.

Fig. 30. Female, dorsal view . . . . . × 26.
Fig. 31. Male, dorsal view . . . . . × 38.
Fig. 32. One of the female antennules (four-jointed) . . . × 154.
Fig. 33. One of the female antennules (five-jointed) . . × 154.
Fig. 34. One of the male antennules . . . . . × 154.
Fig. 35. One of the female antennæ . . . . . × 154.
Fig. 36. One of the female chelipedes . . . . . × 123.
Fig. 37. One of male chelipedes . . . . . × 123.
Fig. 38. One of the uropods, female . . . . × 73.

Macrostylis spinifera, G. O. Sars.

Fig. 39. Female, dorsal view (imperfect) . . . . × 32.

Echinopleura aculeata, G. O. Sars.

Fig. 40. Female, dorsal view (slightly imperfect) . . . × 48.

Leptostylis villosa, G. O. Sars.

Fig. 41. Portion of serrated margin of cephalon . × 514.

VIII.—ICHTHYOLOGICAL NOTES. By T. Wemyss Fulton, M.D., F.R.S.E., Scientific Superintendent.

The Norway Pout (*Gadus esmarkii*, Nilsson.)

The investigations made on board the steam trawler *St. Andrew* in the autumn and winter of last year (p. 58) have added considerably to our knowledge concerning the distribution of this fish. The hauls made with with fine-meshed netting surrounding the cod-end of the otter-trawl yielded large numbers of specimens, sometimes several thousands, and it appears highly probable that the Norway Pout is one of the most abundant gadoids in the northern part of the North Sea. From its small size it is rarely taken with the ordinary appliances used by fishermen, and this is no doubt the reason why it has hitherto escaped notice in this region.

On 31st August and 4th September two hauls were made about 65 miles S.E. by E. of Sumburgh Head, Shetland, approximately in long. 0° 45′ E., and lat. 59° 40′ N., at a depth of 62–66 fathoms. In the first haul, which was for half an hour, the number of specimens of *Gadus esmarkii* taken was 551, and they ranged in length from 110 to 213 mm. In the haul of 4th September, which was for two hours, the number caught was 1211, ranging in size from 51 to 200 mm. In both cases all the specimens had passed through the meshes of the ordinary otter-trawl and were found in the fine-meshed net outside it.

With the exception of the long rough dab, *Gadus esmarkii* was present in these hauls in greater numbers than any other fish, even when the contents of both the otter-trawl and the fine-meshed net are taken into account. The next most abundant gadoid was the haddock.

It was found in even greater numbers in October, about 50 miles further west, namely, about 20 miles S.E. of Fair Isle, approximately in lat, 1° W. and long. 59° 25′ N., and in depths of 60 and 65 fathoms. In a haul on 16th October at this locality, for 1½ hours, 1923 specimens were caught, ranging in size from 66mm. to 197mm.; and in another drag on 19th October, also for an hour and a half, no less than 5084 specimens were taken, of which 257 were measured, the smallest being 31mm. and the largest 168mm. In these hauls it was much more abundant than any other fish.

Other localities where the Norway Pout was taken with a small-meshed net are as follows:—

1. Off Aberdeen Bay:—
   - 12th October, 6 miles from shore, in 32–33 fathoms; 26 specimens from 59 to 107 mm.
   - 13th October, 2¼ miles from shore, in 13–96 fathoms; one specimen, 89mm.
   - 23rd October, 8 miles from shore, in 36–49 fathoms; 201 specimens (in two hauls) from 87 to 117 mm.
   - 24th October, 10 miles from shore, in 60 fathoms; 29 specimens from 88 to 164 mm.

7th November, 10 miles from shore, in from 45 to 53 fathoms; 63 specimens from 80 to 168 mm.

9th November, 1½ miles from shore, in 9 to 10 fathoms; 51 specimens from 83 to 114 mm,

2. Moray Firth:—

3rd November, 3 miles from Lossiemouth, in 11–15 fathoms; 2 specimens between 5 and 6 inches (otter-trawl).

4th November, off Tarbet Ness, in 20 fathoms; 2 specimens (in otter-trawl).

7th November, Dornoch Firth, 12 fathoms; one specimen, 114mm.

8th November, east of Smith Bank, in 35 fathoms; 4 specimens from 84 to 93 mm.

3. Firth of Forth. One specimen was taken in May in 28 fathoms close to the Isle of May.

4. Firth of Clyde. From 1 to 21 specimens were caught in the small shrimp-net of the *Garland* in various hauls made in the Firth of Clyde in from 23 to 45 fathoms in March, August, September, and October. Specimens were also obtained outside the limits of the Firth and within 15 miles of the coast of Ireland, in 67 fathoms. A specimen caught in Lochfyne measured 246mm. and is the largest recorded.

Gadus esmarkii was first discovered by Esmark in the Christiania Fjord, where it is said to be plentiful during the autumn and winter in deep water, generally occurring in shoals with the whiting; it also exists in the Trondhjem and other Norwegian Fjords, and has been recorded by Lütken from the Faröe Islands.* It has been recorded by Petersen and Levinsen from the Cattegat and Skagerrack.† It was added to the British fauna by Dr. Günther, who records it from the Firth of Clyde, the Sound of Mull, Upper Loch Nevis, Loch Sunart, and Loch Aber.‡ Holt found it on the Irish coast, either in the stomachs of fishes or in the nets, off the Kenmare River, the Arran Islands, Clare Island, and Achill Head, the depths ranging from 38 to 144 fathoms, and he has described the eggs and larva.§ The same author records it from the stomach of a halibut trawled on "the south-western flat," a ground which lies due east of the coast of Northumberland between long. 1° and 3°, but chiefly to the western end of long. 2° 30′.‖ Dunn and Holt also record two specimens from the stomach of a pollack caught in a trawl off the mouth of the Bristol Channel, 40 miles N.W. of St. Ives,¶ and Garstang describes a specimen taken on 27th August, 1900, in a tuck-net on the shore of the Hamoaze.** In 1892 Professor M'Intosh described and figured a fish caught with a hook by a St. Andrews fisherman, as "a peculiar example (hybrid?) of the poor-cod (*Gadus minutus*),"†† which appears to be a specimen of *Gadus esmarkii*.

The species has thus been found at various parts around our coasts in recent years, and judging from its numbers in the hauls made with the small-meshed net on board the "St. Andrew," above referred to, and the statements of Holt and Dunn as to its frequent presence in the stomachs

* Fries, Ekstrom and Sundevall. "A History of Scandinavian Fishes," 2nd Ed., revised by Smith, i., 508.

† *Fra den Danske Biologiske Station*, ix., pp. 51, 63 (1900).

‡ *Proc. Roy. Soc. Edin.*, xv., 212, Pl. iii. (1889).

§ *Sci. Proc. Roy. Dublin Soc.*, vii., pp. 122, 399 (1892), ; *Sci. Trans., Roy. Dublin Soc.*, v., 54 ; Holt and Calderwood, *ibid.*, 431 (1895).

‖ *Journ. Marine Biol. Assoc.*, ii., 282 (1892).

¶ *Ibid.*, v., 79 (1897).

** *Ibid.*, vi., 274 (1900).

†† *Eleventh Ann. Rep. Fishery Board for Scot.*, Part iii., p. 241 Pl. xi. 1892).

of fishes, it is probable that further investigation with suitable appliances will show it to be one of the most abundant Gadi in our seas.

The specimens obtained by me comprised the so-called Scotch and Scandinavian types, referred to by Günther,* and intermediate gradations; and while a very large proportion of those taken in the Clyde had one or both eyeballs affected in the manner described by the author named (the cysts, however, containing fine granules), no specimen from the North Sea was observed to be so affected.

Silvery Pout (*Gadus* (*Gadiculus*) *argenteus* (Guichenot.))

Five specimens of this small and rare *Gadus* were obtained in the fine-meshed net in the deep-water hauls. Three were caught on 4th September about 65 miles S.E. by E. of Sumburgh Head, Shetland, in 65 fathoms, measuring 84, 86, and 93 mm.; one on 16th October, measuring 117mm.; and one on 19th October, measuring 93mm., both the latter being procured about 20 miles S.E. of Fair Isle, in 60 to 65 fathoms. None was obtained in the short haul (40 minutes) on 31st August at the locality first mentioned. All the specimens were damaged.

The species was first obtained in the Mediterranean†, and it was again procured by the "Travailleur" in the Gulf of Gascony in 1882, at a depth of 411 metres, as many as 50 specimens being taken in a single haul; and by the "Talisman" off Morocco in 540–550 metres.‡ A specimen taken in 1869 by the "Porcupine," in 183 fathoms, off the south-west coast of Ireland is recorded by Günther,§ and two specimens were procured by Bourne in 1889, in 217 fathoms, also off the south-west coast of Ireland, lat. 49° 5′ 40″ N., long. 11° 14′ W.‖ During the survey of fishing grounds on the west coast of Ireland Holt procured numerous specimens in from 52 to 220 fathoms. He states that it is extremely abundant on that coast locally, and appears to be gregarious at all stages.¶ It has recently been recorded by Petersen and Levinsen from off the Swedish coast in the Skagerrack, one specimen being taken in 95 fathoms and another in 70 fathoms, north of the Scaw.** Hjort also records several specimens from the Christiania Fjord and the Brevik Fjord, in 50 to 60 fathoms.†† Day records a specimen found by Sim in 1885 on the beach at Aberdeen after a storm.‡‡

Couch's Whiting (*Gadus poutassou*, Risso).

In the haul on 4th September, above referred to, 83 specimens of this species were caught in the fine-meshed net. They varied in length from 96 to 160 mm. Two specimens, of 115 and 127 mm., were taken in the haul at the same place on 31st August. One specimen, 129mm. in length, was procured in the haul on 16th October, 20 miles from Fair Isle, and another measuring 159mm. in the haul in the same locality on 19th October.

* *Loc. cit.*

† Guichenot, "Exploration Scientifique de l'Algerie," Poissons, 102, Pl. vi., fig. 2 1851); Günther, Cat. Fish. Brit. Mus., iv. 341 (1862).

‡ Vaillant, "Exp. Sci., Travailleur et Talisman," 302, Pl. xxv., fig. 7.

§ *Ann. and Mag. Nat. Hist.*, xiii., 138 (1874).

‖ *Journ. Mar. Biol. Assoc.*, i. (N.S.), 310.

¶ *Sci. Proc. R. Dub. Soc.* vii., 122, Holt and Calderwood. *Trans. Roy. Dub. Soc.*, v., 434, Pl. xli., figs. 1, 1*a* (1893).

** *Op cit.*, pp. 58, 63.

†† *Rep.* on Norwegian Fishery and Marine Investigations, i., 81, 83 (1900).

‡‡ *Nature.* xxxii. 223 (1885).

The poutassou is described as not uncommon on some parts of the Norwegian coast.* It has been recorded by Couch and others from the English coast;† by Macandrew, Andrews, and Holt from the coast of Ireland;‡ and by M'Intosh from off N. Uist in the Hebrides. Three specimens, between 6 and 7 inches long, were obtained by Mr. F. G. Pearcey in the shrimp-trawl of the "Garland" at the mouth of the Firth of Clyde, in 54 fathoms, in September, 1897.§

The present record is, so far as I am aware, the first for the western part of the North Sea. Holt mentions that a large shoal, all ranging from 5½ to 6 inches in length, was observed by him at the surface, 34 miles off Achill Head, on the west coast of Ireland. It is possible that the specimens obtained by me were caught in the surface waters as the trawl was being hauled, although the number taken scarcely supports this view.

THE HEBRIDEAN SMELT OR ARGENTINE (*Argentina sphyræna*, Linn.).

A considerable number of specimens of this species, of varying size, were obtained in the fine-meshed net in the hauls in deep water. On 31st August, in 65 fathoms, about 65 miles S.E. by E. of Sumburgh Head, 18 specimens were procured, ranging in length from 120mm. to 243mm. In the other haul in the same locality on 4th September, 20 specimens were taken, from 109mm. to 228mm. in length. The haul on 16th October, off Fair Isle, yielded 39 specimens, ranging from 118mm. to 205mm.; and that on 19th, in the same locality, other 7 specimens from 92mm. to 184mm.

This species was recorded by Yarrell from the Firth of Clyde and from the Yorkshire coast, three specimens in all having been obtained.‖ Day described and figured a specimen taken in 1879 near Lochalsh, Skye;¶ Edward recorded a specimen from the Moray Firth in 1879,** and Günther records eight specimens from the Clyde in 1888.†† Since then numerous specimens have been obtained by the shrimp-trawl of the "Garland" at various places in the Firth of Clyde.‡‡ During the Irish Survey, Holt procured a considerable number of examples, about 1½ inches long, at 62 to 55 and 80 fathoms off the Skelligs; specimens were also taken at 40 fathoms, and from the stomach of a sharp-nosed skate trawled at 375 to 500 fathoms.§§

The species has been found at various parts of the Norwegian coast, although not in large numbers, and it is stated to be taken to market at Christiania almost daily in autumn.‖‖ The largest specimen procured by me was 243mm., or $9\frac{9}{16}$ inches, which was also the size (9½ inches) of the one described by Day. One of Yarrell's specimens, from Rothesay Bay, measured 8 inches, and the other was 6 inches; Edward's example was 8¼ inches, while Holt's specimens were under 6 inches in length. The largest of Collett's, from Norway, was 265mm., or $10\frac{7}{16}$ inches. All my specimens were more or less rubbed and frayed in the trawl, and having

* "Scand. Fishes," i., 371.
† "Fish. Brit. Isles," iii., 77, Pl. cxli. Day, "Brit. Fishes," i., 293, Pl. lxxxiii., fig. 1.
‡ Holt and Calderwood, *ibid.*, 430.
§ *Sixteenth Ann. Rep. Fishery Board for Scotland*, Part iii., p. 54 (1898).
‖ Yarrell, "Brit. Fishes," 3rd Ed., i., p. 300.
¶ *Journ. Linn. Soc.*, xv., 83, pl. iv. (1881).
** *Ibid.*, 334.
†† *Proc. Roy. Soc. Edin.*, xv. p. 213 (1889).
‡‡ *Sixteenth Ann. Rep. Fish. Board for Scot.*, Part iii., pp. 49-56; *Seventeenth Report, Part iii.*, pp. 55–60.
§§ *Roy. Dub. Soc. Rept. of Council*, App. C., p. 300. Holt and Calderwood. *Sci. Trans. Roy. Dub. Soc.*, v., 509 (1895).
‖‖ "Scandinavian Fishes," ii., p. 918.

been for some time in a solution of formaline prior to examination, the viscera were not very well preserved. The abdominal cavity contained a considerable quantity of fat. According to Risso, this species breeds in the Mediterranean in the spring. Yarrell's specimen, taken in June, was full of roe, and Collett obtained a gravid female in the same month, and females were found full of roe in the Christiania Fjord. One of the females taken by me on 31st August, 239mm. in length, contained eggs, densely yolked, 0·36mm. in diameter. Another, of 232mm., and a third, of 122mm., taken at the same time, had eggs measuring 0·7mm. The ovaries in all these examples were small. A female, 180mm. long, caught on 16th October, had ovaries considerably enlarged, and eggs measuring up to 1mm.; the great majority of the specimens were, however, immature. In May, in the same region, S.E. of the Shetland Isles, most of those taken were approaching ripeness, with enlarged ovaries, and the eggs measured up to 1·1 mm. The spawning time, in the area referred to at least, appears to begin in June, although an isolated specimen was got with large eggs in October. Judging from the dense condition of the yolk, the thickness of the zona, and the resistance to rupture by pressure, the eggs are probably demersal. Minute oil-globules, as well as yolk-spheres, exuded on pressure.

The Greater Argentine (*Argentina silus* (Ascanius)).

Four examples of this species were taken on 19th and 21st May last in hauls made by the steam-trawler "Star of Peace," approximately in lat. 60° N. and long. 0°25 E., in 65 fathoms. The locality is about 15–20 miles due north of the place where the hauls were made in August and September. Mr. H. Dannevig, who was on board, measured the specimens and preserved one of them, which is now at the Marine Laboratory, Bay of Nigg. The sizes were 303, 383, 379, and 418 mm. Other two argentines were taken in 75–78 fathoms, 22 or 75 miles E. of N. Unst, Shetland (the precise locality was not ascertained), which were not preserved, but as they measured 270 and 295 mm., both, or at least the larger, probably belonged to this species. The specimen preserved measures 379mm.; the largest (418mm.) was cooked and eaten under a misconception. Its flesh was rich and fat.

There appears to be no previous record of this fish having been found in the British seas. Edwards described an argentine as *A. silus*, which was procured in the Moray Firth in 1879; but it was shown to be an example of *A. sphyhræna*.* It is, however, not uncommon in the deep fjords of Norway, and has been found in the Skagerrack. According to Collett, its range extends from the entrance of the Christiania Fjord along the whole coast to Tromsö.†

Brown, Goode, and Bean state that three specimens have been procured on the American coast, viz., one at Sable Island Bank, taken from the stomach of a *Phycis* caught at 200 fathoms; one caught by hook and line in the harbour of Belfast, Me., and the third at Biddeford Pool, Maine.‡

The authors of the *Scandinavian Fishes* say that it attains a length of nearly 50cm., and even according to Nilsson 59cm. The largest specimen seen by Collett measured 47·5cm. Two of the American specimens were 18 inches and 15 inches respectively.

* *Jour. Linn. Soc. Zool.*, xv., 334 (1881).
† "Scandinavian Fishes," ii., 913.
‡ "Oceanic Ichthyology" i. 52. ii.. fig. 61 (1895).

THE SHARP-TAILED LUMPENUS (*Lumpenus lampetræformis*, Walbaum).

In the haul on 31st August above referred to, 65 miles from Sumburgh Head, seven specimens of this species were procured, and other four examples were taken in the haul of 4th September in the same locality. They measured from 84mm. to 333mm. None were procured in the hauls in October mentioned above. A specimen was also obtained in the stomach of a picked dog-fish (*Acanthias vulgaris*) trawled in 50 fathoms in the Moray Firth about 12 miles off land on 3rd November, 1900. The anterior two-thirds of this specimen were partly digested, the remainder being practically intact.

This blenny was first recorded as belonging to the British fauna by Day, who described and figured a specimen trawled 15 miles off St. Abbs Head, in 40 fathoms, in May, 1884.* It was recorded from the Firth of Clyde (20 and 60 fathoms) by Günther in 1888,† and since then it has been frequently taken at various parts of the Clyde in the shrimp-net of the "Garland."‡ On the East Coast specimens from the Moray Firth were recorded by Sim in 1887,§ and it has since been frequently found, sometimes in large numbers, in or near the Firth of Forth. ‖ Holt records two specimens taken in 23–25 fathoms 240 miles E. ½ N. of the Spurn Light-vessel (about 50 miles off the coast of Denmark) in July, 1892; and he states that Dr. Günther informed him that he had seen a specimen said to have been taken on the coast of Norfolk.¶ It was not apparently obtained during the Irish Survey.

Lumpenus has been found in the Baltic, on the Bohuslän coast of Sweden, in the Christiania Fjord, and, more commonly, on the west coast of Norway, where it is most numerous in the extreme north in Finmark. It has also been obtained at Iceland, Spitzbergen, and Greenland, and is really an arctic species.** It is said by the Scandinavian authors to attain a length of 412mm. It exists in great numbers towards the mouth of the Firth of Forth, as many as 135 specimens having been taken in a single haul at the end of April, and 255 in a haul in May.

It is believed to spawn on the Norwegian coast in winter. Of the eleven specimens above referred to taken off the Shetlands, 7 were females, 3 were males, and the sex of two was not determined. Their sizes, in mm., were as follows:—Females, 234, 258, 265, 272, 274, 278, and 286; males, 283, 303, 333; undetermined, 154, 84. The females had well-developed ovaries, which were confluent, except in some cases for the anterior third; they occupied the posterior half of the abdominal cavity. In a specimen 258mm. long, they measured 35mm. in length, 8mm. broad transversely, and 10mm. deep. The eggs in this female were from 1·15mm. to 1·25mm. in diameter. In another, measuring 274mm., the eggs ranged from 1·1mm. to 1·35mm., and on careful search I found one egg the diameter of which was 1·44mm. The specimen, 9½ inches long, described by Professor M'Intosh,†† which was caught on 23rd February, had eggs measuring from 0·229 to 0·3048 mm. The number of eggs contained in the ovaries was not very great; the egg-capsule was relatively thick and resistant to pressure

* *Second Ann. Rep. Fishery Board for Scotland*, p. 78, Pl. x. (1884). *Proc. Zool. Soc.*, 1884, 445, Pl. xli.
† *Proc. Roy. Soc. Edin.*, xv., 211 (1889).
‡ *Sixteenth Ann. Report Fishery Board for Scotland*, Part iii., p. 51, &c.
§ *Jour. Linn. Soc.*, xx., 38.
‖ *Seventh Ann. Rep. Fishery Board for Scot.*, Part iii., 326; *ibid.*, *Eighth Report*, 357; *Twelfth Report*, Pl. iii., fig. 10.
¶ *Journ. Marine Biol. Assoc.*, iii., 120.
** "Scandinavian Fishes," i., 224, Pl. xi., fig. 5.
†† *Twelfth Ann. Rep. Fish. Board for Scotland*, Part iii., 225.

under a cover-glass, the yolk was very dense, and contained minute oil-droplets. I have little doubt the eggs are demersal, and so far as could be judged spawning was likely to occur in October or November, but it might be later, in which case the eggs must be considerably larger. The stomachs of all the specimens contained the remains of annelids and numerous grains of sand which rendered the contents gritty; in some cases fragments of tubes of sand-grains were observed.

The Norway Haddock (*Sebastes marinus* (Linn.)).

Sixteen specimens were obtained in the deep-water hauls on October 16th to 20th, in from 60–67 fathoms, 17 to 25 miles S.E. of Fair Isle They measured from 87mm. to 258mm. In a female 250mm. long, the largest eggs measured 0·33mm.; in others 121mm. and 125mm. in length they were almost as large (0·32mm.); in one 140mm. long they measured 0·34mm.; in the specimen of 87mm. they were minute. The colour of the ovaries was brownish yellow, apparently partly due to interstitial oil; the eggs, which were densely yolked, also contained yellowish oily droplets and a thick zona. No embryos were present.

The Spotted Dragonet (*Callionymus maculatus* (Bonaparte)).

In the haul on 16th October, off Fair Isle, five specimens of this species were obtained in the fine-meshed net, measuring from 87 to 100 mm. On the 19th, in the same locality, other eight specimens were procured, of which six were males from 80 to 126 mm., and two were females, measuring 88 and 89 mm. In the Moray Firth, on 22nd June, in 40 fathoms, a specimen 82mm. long was taken; another was caught in 37 fathoms on 14th June which measured 81mm., and a third, measuring 91mm., on 22nd May, in 35 fathoms. The latter was a female with well-developed ovaries, and eggs approaching ripeness having a diameter of 0·67mm.

In the Clyde it was first obtained by Günther,* and has since been taken there on several occasions in the small shrimp-net of the "Garland." Eight specimens, for example, were taken in one haul in 30 fathoms, on 30th August, off Turnberry Point, and other eight at the same place on 16th October. It was obtained by Holt on the west coast of Ireland,† and the same naturalist has since recorded a male from 30–35 fathoms in Falmouth Bay.‡

The Herring (*Clupea harengus*, Linn.).

It may be worth while recording the fact that a few large, nearly ripe, herrings were taken in the trawl-net at the beginning of September, about 65 miles S.E. by E. of Sumburgh Head, Shetland, where the water was 62–65 fathoms deep. Two males measured 314 and 304 mm., the testes in the former being nearly ripe, and in the latter quite immature; a female, measuring 309mm., had large full ovaries, the eggs measuring from 0·92mm. to 1·1mm. I thought at the time that these herrings had probably been caught by the net as it was being hauled, but since I found very large herrings in the same condition in the stomachs of anglers trawled at the same place—in one case five—there is little doubt a shoal

**Proc. Roy. Soc. Edin.*, xv.
†Holt and Calderwoood, *op. cit.*
‡*Jour. Marine Biol. Assoc.*, v., 90 (1897).

was present on the grounds, and judging from the condition of the ovaries the herrings were about to spawn. Considerable quantities of herrings were landed by the Aberdeen trawlers during the course of the summer which were caught in deep water.

Young Fishes on the Deep-Water Grounds.

It is noteworthy that very few young specimens even of the commonest kinds of fish were procured in the hauls of the fine-meshed net on the deep-water grounds on August 31st, September 4th, October 16th and 19th. Only 49 young whitings (over a year old) were taken in the four hauls, while thousands were caught in a single haul in the waters near shore (*see* p. 167). The number of young haddocks was also inconsiderable and out of all proportion to the abundance of the adolescent and mature individuals. In the four hauls the number taken was 496; the smallest was 61mm., or $2\frac{3}{8}$ inches, on 4th September; 68mm. on 31st August, 84mm. on 16th October, and 82mm. on 19th October. They were also scarce in the inshore waters (contrasting in this respect with the whiting), and were no doubt above the bottom leading a pelagic life. The young of *Gadus esmarkii*, on the other hand, were very abundant. It may be mentioned that by far the most important catches of the trawlers on these off-shore grounds consist of haddocks, of which great numbers are taken in late summer, autumn, and winter, but after the spawning season they become very scarce, and the fishing is barely profitable towards the end of April and in May and June. It is believed by the trawlers that they rise from the bottom at this time, and therefore beyond the reach of the net. Some trawlers who have "prospected" on the edge of the deep water, in over 100 fathoms, state that they are even less numerous there.

Young cod were almost entirely absent from the deep-water grounds, although codling were present in numbers. None was obtained in the hauls on 31st August and 4th September; on 16th October one, which, however, was large, measuring 245mm., or $9\frac{5}{8}$ inches, was taken, and in the haul of 19th October there were two, measuring 122mm., and 88mm. ($4\frac{3}{16}$ and $3\frac{7}{16}$ inches). These were not improbably caught as the net was being hauled. Young cod were taken in numbers—although in far less abundance than the whiting— in the shallow inshore water.

It may be regarded as fairly certain that the young of the Gadi mentioned lead a pelagic life, young cod and whiting migrating in large numbers to the inshore waters, while the young haddock keep more to the open sea.

No small green-cod, pollack, ling, hake, or tusk were taken on the deep-water grounds. The smallest hake caught measured 42 cm. ($16\frac{1}{2}$ inches). Adult gurnards were much less common than nearer shore, and only one small one, measuring 131mm. ($5\frac{1}{8}$ inches), was caught. Young gurnards were not uncommon inshore.

Among flat-fishes, young individuals of the sail-fluke or whiff (*Arnoglossus megastoma* (Donovan)) and of the witch or pole-dab (*Pleuronectes cynoglossus*, Linn.), species present in considerable numbers on the deep-water grounds, were rare. The smallest example of the former obtained (from 65 fathoms, on 19th October) was 145mm. ($5\frac{3}{4}$ inches). The smallest witch measured 196mm. ($7\frac{3}{4}$ inches). Lemon soles were fairly numerous in the deep water; the smallest obtained was 177mm. ($4\frac{5}{8}$ inches); others measured 135, 152, 154, 162, and 166 mm.

Common dabs were much less abundant than on the inshore grounds,

and young examples were scarce. In the four hauls with the fine-meshed net 75 specimens were procured, ranging from 209 to 82 mm. There were only two small specimens (82 and 87 mm.), those next largest measuring 113, 120, 121, 125, and 127 mm.

Long rough dabs, on the other hand, were present in profusion, being, with the exception of the Norway pout, the most abundant fish on the grounds, and very small specimens were well represented. In the four hauls with the fine-meshed net referred to, 4809 were taken, ranging in size from 31mm. ($1\frac{3}{16}$ inches) to 267mm. ($10\frac{1}{2}$ inches).

Specimens considerably larger, up to 35cm., have been taken nearer shore in moderately deep water, and I may state that the largest specimens obtained of common dabs, haddocks, and even plaice, were taken within a few miles from shore in the Moray Firth or Aberdeen Bay. A considerable number of large haddocks, most of them thin and in poor condition, and measuring from 63 to 71·2 cm., were obtained in the places named. The largest specimens from the deep-water grounds visited measured 67, 66, 65·2, 64·8 cm.

The Porbeagle (*Lamna cornubica*).

In a haul made by the steam-trawler "St. Andrew" in the Dornoch Firth, in 12 fathoms of water, on 5th November last, a porbeagle shark measuring 7 feet 4 inches in length, was caught in the net. The contents of the stomach were as follows:—A half-digested flat-fish, about 6 inches in length; a half-digested haddock, about 14 inches long; one swimming crab, one anemone, the bones of a cod, the skull of which was about six inches in length, and the remains of what appeared to be a cuttle-fish

The Opah or King-Fish (*Lampris luna*, Gmelin).

A fine specimen of this fish was forwarded in ice from Shetland, on 20th October, 1900, by Mr. Hendry, the Fishery officer. It was caught alive on 18th October, close to the beach at Biskie's Gio, East Voe, Scalloway, and measured $3\frac{1}{2}$ feet in extreme length, $22\frac{1}{2}$ inches in depth, and weighed 85lbs. It was a female with well-developed ovaries; one was 29cm. long by 7cm. deep, and it weighed 276 grammes; the other was 24cm. long and weighed 255 grammes. They were conical, thin-walled and soft, and liver-coloured. The dusky colour was found to be due to the large quantity of blood they contained, the tissues appearing, on microscopic examination, extremely and unusually vascular. The interior of the ovaries presented a considerable cavity; the ovigerous surface was densely papillose and contained an enormous number of eggs. The largest eggs measured 0·82mm., they were yolked, but not densely opaque; the zona was smooth, transparent, and colourless, and, although somewhat resilient, comparatively easily ruptured. The germinal vessel in eggs of 0·7mm. measured 0·115mm.

Judging from the character of the eggs and their great numbers, I think they are probably pelagic; the spawning period can only be conjectured.

The stomach was found to contain a large number of the mandibles of a cephalopod.

The Torpedo (*Torpedo nobiliana*, Bonaparte).

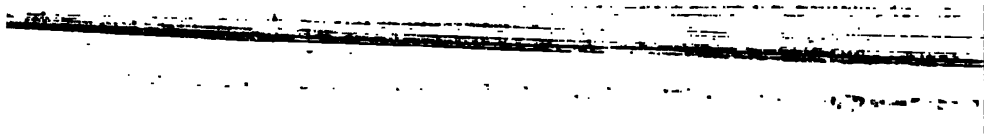
A specimen of this somewhat rare form was caught on 14th February last year, one-and-a-half miles from Tarbet Ness, in the Moray Firth, in

16 fathoms of water, and was forwarded by Mr. Robert Hendry, Fishery Officer. It was taken by the crew of a Burghead boat (the "Henry Smith"), who found it entangled in their herring net close to the top, near the corks. Mr. Hendry mentioned that two of the crew received a "shock" of electricity on handling the fish when taking it from the net.

The specimen measured 73·5cm. in extreme length, 55cm. in extreme breadth across the pectorals, and 6cm. in greatest thickness; it weighed 14 lbs. On the upper surface it was of a very dark slate colour, almost black, while the lower surface was white. It was not opened.

A specimen of the Torpedo was recorded, also from the Moray Firth, in 1884.* It was caught in a trawl off Lybster, Caithness, in 40 fathoms, and was a little smaller than the one now recorded, being 29 inches long; the upper surface was of a uniform dark chocolate colour. Other specimens have been recorded from the East Coast.†

* *Second Ann. Rep. Fishery Board for Scot.*, p. 79, pl. xi.
† *Ann. Scot. Nat. Hist.* for 1895, pp. 197, 198.



Showing the Condition and Financial Value of the Articles.

The Proceedings of Parliament in Public and Private Business are published daily—
House of Lords, price 1d. per 8 pp.; House of Commons, 1d. per 4 pp.

Trade Reports of the several British Colonies, with information relative to their population and general condition.

Trade Reports by His Majesty's Representatives in Foreign Countries, and Reports on Commercial and Consular Subjects.

Special Reports on Educational Subjects. Issued by Board of Education:—

Public Libraries and Private Educational Endowments. The circumstances answered. [Price 2½d.
Physical Measurement of Children. [Price 1d.
Technical Instruction in Belgium, Holland, and Germany. [Price 6½d.
Agricultural Schools in Europe. [Price 2½d.
Secondary Schools in Prussia. [Price 1s.
Universities and Technical Institutes in France. [Price 8½d.
Intermediate Education in Wales and the Organisation of Education in Switzerland. [Price 1s. 1½.
Superannuation in Foreign Services. Report of the French Minister for Public Instruction, 31st February, 1891. [Price 1d.

Military:—

Africa, South-East—Photographs and Sketches. Price of Information concerning. [Price 1s.
Barracks. Cost of Construction in 1901. [Price 3½.
Commissariat Manual of Provisional Service. [Price 1s.
Gold Coast Northern Territories of. Report on. Compiled by the late A. Ellis, H. P. Northcott, C.B. [Price 6d.
Position Finder Handbook. 1897. [Price 2s.
Sweden and Norway. Armies of. Handbook. By Major J. H. V. Cross, R.A., Staff Captain. [Price 1s.
Volunteer Fund. Regulations. 1901. [Price 1d.

Hydrographical:—

Pacific Cable Route. Province. Report on Soundings of H.M.S. "Penguin." [Price 9d.
Tidal Curve Rules and Notes. Temperature Observations Received at the Admiralty during the Year 1901. [Price 1s.

Local Government Board:—

Sanitary Circumstances and Administration of the Urban District of St. Helens. [Price 2d.
Isle of Wight. Report on. [Price 2d.
Sanitary Circumstances and Administration of the Bournemouth Urban District. Report on. [Price 2d.

Emigrants' Information Office, 31 Broadway, Westminster, S.W.:—

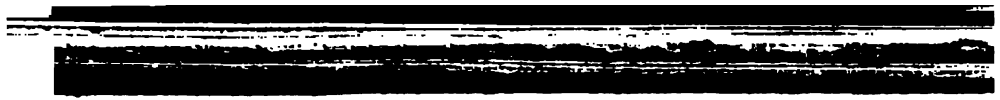
Canada. Handbooks for. April 1901. See Wrapper.
No. 1. Canada. 2. New South Wales. 3. Victoria. 4. South Australia. 5. Queensland. 6. Western Australia. 7. Tasmania. 8. New Zealand. 9. Cape Colony. 10. Natal. [Price 1d. each.
No. 11. Professional Handbook dealing with Professions in the Colonies. [Price 2d. each.
Emigration Statistics and General Handbook. [Price 4d.
Nos. 1 to 12, in cloth. [Price 4d.
Nos. 1 to 12, in cloth.
Foreign Reports, 1901. Summary of. America, North and South. July 1901. [Price 2d.

Information Pamphlets. Immediate application—Argentine Republic, price 2d. California, price 1d. Ceylon, Oct. 1899, price 6d. Federated Malay States, 1901, price 6d. Maryland, price 1d. Newfoundland, price 1d. South African Republic, price 2d. West Indies, price 6d.

Foreign Laws. Translations of Abstracts of the Laws relative to the Estate, &c., of Deceased Persons. Annual Volume of Inland Revenue. [Price 10s.

Foreign Office:—

Africa by Treaty. The Map of. By Sir E. Hertslet, K.C.B. 2 Vols. [Price 21s. 6d.
Commercial Treaties, (Hertslet's) A complete collection of Treaties, &c., between Great Britain and Foreign Powers so far as they relate to Commerce and Navigation. Vol. 19. By Sir E. Hertslet, K.C.B., &c. Vols. I. to XX. [Price 15s. each.
Vol. 20. By Sir E. Hertslet, K.C.B., &c. Vols. I. to XX. [Price 15s. each.
State Papers. British and Foreign. Vol. 81. General Index to the volumes, 61 to 70 (1873 to 1880). Vols. 71 to 80 (1880 to 1889), alphabetically arranged. [Price 10s. each.

Board of Trade Journal. A Tariff and Trade Notices and Miscellaneous Commercial Information. Published weekly. [Price 1d.
Index to Vols. I. to IV. Price 2s. And to Vols. V. to X. July 1893 to June 1896. [Price 1s. 6d.

Port of London Commission:— Minutes of Evidence. [Price 1s. per Vol.
Appendices. [Price 2s. per Vol.